The American Midland Naturalist

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Vegetation of the Patuxent Research Refuge, Maryland

Neil Hotchkiss and Robert E. Stewart

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Introduction

The information upon which this report is based was gathered during the years 1936-1946. A preliminary study of the flora and plant communities was made during the first four years and was summarized in mimeographed form in 1940[1]. Since that time the authors, with the assistance of W. R. Greiner and J. W. Brainerd, made a detailed study of the plant communities. During the same period these workers, together with F. M. Uhler, W. H. Stickel, and A. C. Martin of the Refuge staff, and F. J. Hermann and S. F. Blake of the Department of Agriculture's Bureau of Plant Industry, Soils

1 Hotchkiss, Neil. 1940—Flora of the Patuxent Research Refuge, Maryland. U. S. Dept. of the Interior, Bureau of Biological Survey Wildlife Leaflet BS-154.

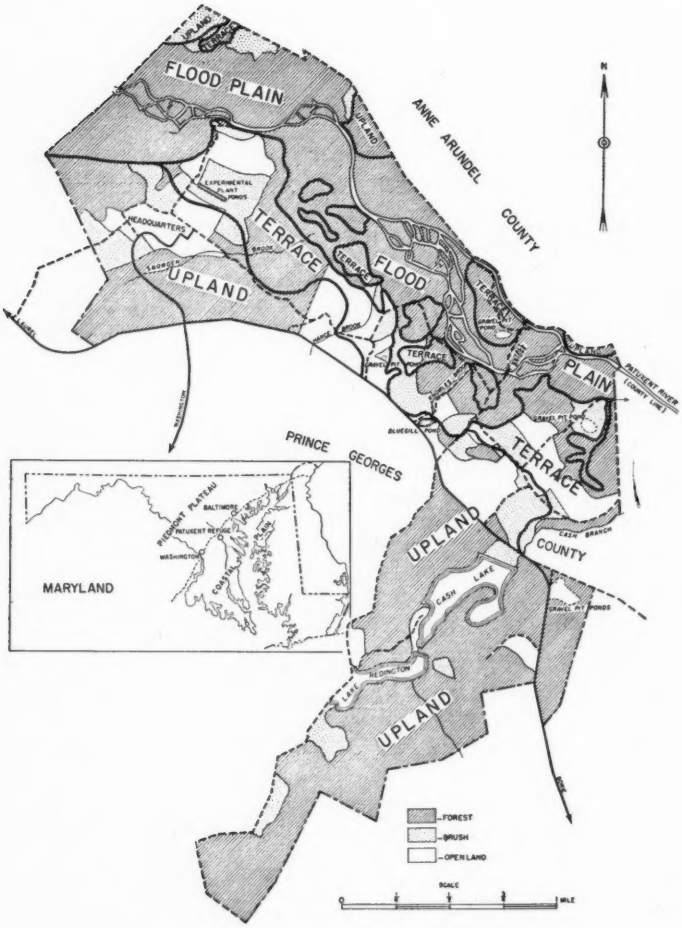

Fig. 1.—Physiography and Plant Cover of the Patuxent Research Refuge. (Drawn by Mrs. Katheryne C. Tabb).

and Agricultural Engineering, have added one hundred and forty-eight species to the original list of plants and have amplified the knowledge of plant distribution and abundance.

Physical Characteristics of the Area

LOCATION

The Patuxent Research Refuge is an area of approximately 2,650 acres where research in wildlife management is being carried on under the administration of the Fish and Wildlife Service of the United States Department of the Interior. It is located in the Patuxent River watershed in Prince Georges and Anne Arundel Counties, Maryland, midway between Baltimore and Washington (see map, p. 2 and the War Department's Laurel Quadrangle). The United States Department of Agriculture's Agricultural Research Center at Beltsville, Md., adjoins the Refuge on the west; Fort George G. Meade adjoins it on the northeast.

CLIMATE

The Refuge lies in a region of cool winters, hot summers, and high relative humidity. Temperatures much above or much below the average may occur at any time during the year. Precipitation is rather evenly distributed throughout the year, being slightly higher in summer and lower in fall than in winter and spring. However, like temperatures, precipitation much above or much below the average may occur at any time of the year. Snowfall usually is light and rains occur frequently during the winter.

At the Bell weather station near Glenn Dale, Md., three miles south of the Refuge, records have been kept for 25 years. According to the 1945 summary of these records[2] the average annual temperature is 54° and monthly averages vary from 34° in January to 76° in July. The 1945 minimum was —4°, the maximum was 98°. The time between the last killing frost in spring and the first in the fall is usually about 175 days. The average annual precipitation is 42½ inches, and monthly averages vary from 2½ inches in December to 4½ inches in August. The prevailing winds are moderate and are from the northwest.

PHYSIOGRAPHY

The greater part of the Refuge is situated within the valley of the Patuxent River, which at this point, is about 3 miles wide and 150 feet deep. Altitudes vary from 80 feet above sea level along the river at the east end of the Refuge to 240 feet at the south end. The river falls about 25 feet in its crooked, 3½-mile course across the Refuge, traversing for the entire distance a flood plain that varies from one-quarter to one-half mile in width (see map, p. 2). On the south side of the river irregular areas of broad, nearly level terrace adjoin the flood plain in most places and lie less than 15 feet above it. Low bluffs separate flood plain and terrace. Back of the terrace the land in

2 1945—Climatological Data, Maryland and Delaware Section (U. S. Dept. of Commerce, Weather Bureau) **49**:49-52.

most places slopes gently but irregularly to broad hilltops. In a few places on each side of the river the upland adjoins the flood plain and is separated from it by steep bluffs up to 50 feet in height. "Islands" of terrace with a relief of less than 5 feet are frequent on the flood plain.

In two-thirds of its course across the Refuge the Patuxent River has a braided channel, while further back on the flood plain are many shallow runs that go dry in summer. In most years the flood plain is flooded briefly one or more times, but usually the river flows between well-defined banks. Near the river the flood plain is well drained. Away from it much of the plain is permanently swampy because of its lower altitude and lack of drainage. Some of these swamps are partly fed by springs that occur along the foot of the bluffs.

Several brooks rise just outside the boundary of the Refuge and flow into the river. They are so small that the majority do not produce channels across the flood plain but disappear in alluvial fans or lose their identity in shallow runs. Along their valleys on terrace and upland are many seepage swamp areas. One and one-half miles is the greatest length of any brook except for Cash Branch (the southeasternmost) which has a length of over three miles and drains the entire south end of the Refuge. Its lower course is outside the Refuge. Further upstream it has been dammed to form two lakes, Cash Lake with an area of approximately 50 acres, Lake Redington of 25 acres. Bluegill Pond, formed by the damming of Knowles Brook, has an area of 2 acres. Shallow ponds occur in three gravel pits on the terrace and in one on the upland. Water is piped to a series of twenty-four 20x50 foot experimental plant ponds near Headquarters. All of the ponds except those in two of the gravel pits were constructed since 1937.

GEOLOGY AND SOILS

The Refuge is situated only a few miles from the inner boundary of the Atlantic Coastal Plain and lies within the Fall-line Clay Hills district[3]. The rocks are unconsolidated sediments, nearly all of Lower Cretaceous age. The principal formations are the Arundel and Patapsco[4]. Crystalline rocks form the nearby Piedmont Plateau.

Most of the soil materials have originated from the weathering of the underlying Coastal Plain sediments. A few soil materials have been transported short distances by streams; that for one soil, the Congaree Silt Loam, has been carried from the Piedmont by the Patuxent River[5]. This soil maintains high fertility through continued alluviation. The opposite extreme is the infertile, highly erodible Tuxedo soil which occurs on much of the steeper land of the southern part of the Refuge. Between the two extremes are a considerable number of soils of varying fertility. In texture the soils vary

3 Harper. Roland M. 1918—A phytogeographical sketch of southern Maryland. Jour. Wash. Acad. Sci. 8:581-589.

4 Miller, Benjamin L. 1911—The geology of Prince George's County. Maryland Geol. Survey, Prince George's County, pp. 83-136.

5 Perkins, S. O., and Bacon, S. R. 1925—Soil survey of Prince Georges County, Maryland. U. S. D. A. Bur. of Chemistry and Soils.

from silt loams to gravelly sands; in water-holding capacity they vary from those that are waterlogged to those that are excessively drained. In most of the soils the content of organic matter is low. The hydrogen-ion concentration ranges from neutral to strongly acid.

Plant Communities

The Patuxent Research Refuge is located within a major vegetational region which may be designated as the Central Pine-Oak Region. This is an ecotone between the Central Hardwoods Region (Upper Austral Zone) and the Southern Pine-Oak Region (Lower Austral Zone). The Central Pine-Oak Region extends from Cape Cod to central Georgia and north on the west side of the Appalachians to southern Ohio and thence to the Ozarks. The Refuge, itself, is situated much closer to the Central Hardwoods Region than to the Southern Pine-Oak Region and is characterized by a greater number of species typical of the Central Hardwoods.

The characteristic vegetation of the Central Pine-Oak Region in the vicinity of the Refuge apparently is due largely to changes in edaphic conditions within the last three centuries. During this period much of the fertile topsoil has been eroded and light and moisture conditions have been changed. This has resulted in a change from a mesophytic forest to one including many trees characteristic of sterile soils. A short distance south of the Refuge, on the rich Collington Fine Sandy Loam of the Greensand district[3], small tracts of the original type of forest still persist. This forest is very similar to the Central Hardwoods forest (Oaks-Chestnut-Tulip-tree) found on the Piedmont Plateau of Maryland and undoubtedly represents the climatic climax for the region. The plant communities of both the Coastal Plain and Piedmont Plateau of Maryland have been outlined by Shreve and others[6]

The report of the 1907 forest survey of Prince Georges County[7] relates how agriculture, selective cutting, and fires have changed the forests from their original predominantly mixed hardwood composition. Among the hardwoods, many stands that were originally of nearly pure White Oak have, through constant culling, given greater prominence to other oaks. On poorly drained sites Red Maple and Blackgum have become much more prominent than formerly. Forest fires have reduced the abundance of Tulip-tree and Chestnut. Since the report was written the latter has been nearly eliminated by blight.

The greater part of the Refuge is now forested (less than 200 acres open, less than 400 acres brush—see map, p. 2) but, excepting the flood plain, nearly all appears to have been in cultivation at some time within the last one hundred years. Even the flood plain forest has been logged over, except on some of the islands between the river channels. The flood plain forest is composed entirely of hardwoods. The terrace and upland forest, in contrast,

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6 Shreve, Forrest, and others. 1910—The plant life of Maryland. Maryland Weather Service Special Publication 3.

7 Besley, F. W. 1913—The forests of Prince George's County. Maryland State Board of Forestry.

comprises stands of pure pine, of mixed pine and hardwoods, and of pure hardwoods. Each stand of pine is even aged and each occupies a formerly cultivated field.

Most of the plant communities of well-drained terrace and upland represent stages of recovery from cultivation. In this recovery annual weeds are the pioneers. They invade the corn and soybean fields and the gardens, and even the wheat and hay fields, and without continued cultivation they soon become dominant. In the fallow fields perennial species become more abundant with each succeeding year of abandonment. Within three years Broomsedge *(Andropogon virginicus)* is dominant in many places. It is regularly replaced by pines, which often appear as seedlings almost simultaneously with the Broomsedge. Seedling pines grow in a few years to form even-aged, usually closed stands that ultimately are invaded by deciduous trees.

In the recovery of poorly-drained terrace and upland from cultivation, annuals, likewise, are the pioneers; but the percentage of native species is much higher than on well-drained land. Here, too, perennials quickly take over from the annuals; but they are wet-meadow species which, in turn, are quickly dominated by invading Sweetgum *(Liquidambar styraciflua)* or, locally, by Pitch Pine *(Pinus rigida)*. These develop into dense stands that finally are invaded by a variety of deciduous trees.

On the flood plain the composition and relationships of plant communities are complicated by differences in water supply, whether from stream overflow or from seepage springs, by differences in drainage, and by differences in deposition of alluvium. On well-drained sites a mesophytic deciduous forest quickly develops. On poorly-drained sites marsh-meadows are replaced by shrub swamps, shrub swamps by either of two types of swamp forest. These changes take place slowly except where there is considerable deposition of alluvium.

Two recent, detailed descriptions of the plant communities of widely separated areas show striking similarities to the communities of the Patuxent Refuge. The Illinoian till plain of southwestern Ohio[8], with similar conditions of soil moisture and acidity, has vegetation similar to the Patuxent swamps of both lowland and upland. The North Carolina Piedmont[9], with similar soil conditions, has vegetation similar to that of the succession of communities on the Patuxent terraces and upland.

A few areas on the Refuge represent an interspersion of types, due to intermediate environmental conditons. These areas are not readily classified into definite plant community types. The composition and relationships (see chart, p. 7) of the typical plant communities are described in the following pages.

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8 Braun, E. Lucy. 1936—Forests of the Illinoian till plain of southwestern Ohio. Ecol. Monog. **6**:89-149.

9 Oosting, Henry J. 1942—An ecological analysis of the plant communities of Piedmont, North Carolina. Am. Mid. Nat. **28**:1-126.

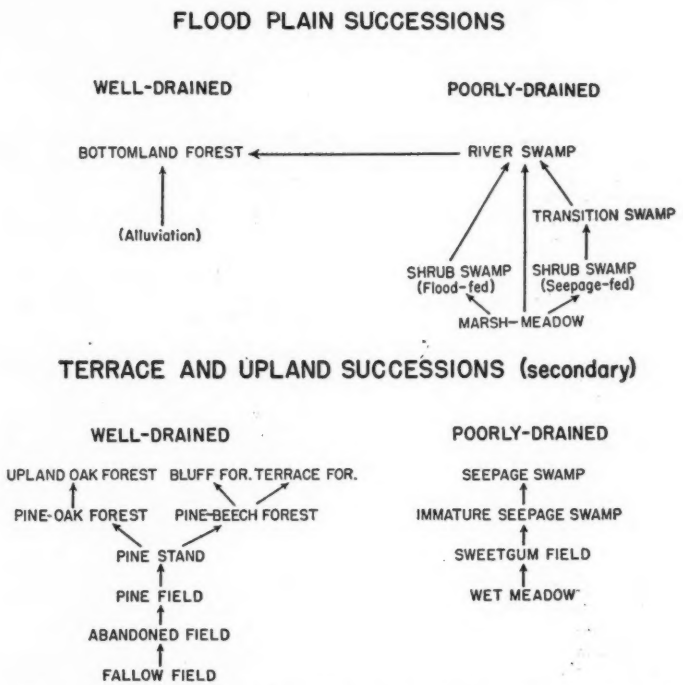

Fig. 2.—Succession of Plant Communities on the Patuxent Refuge. (Drawn by Mrs. Katheryne C. Tabb).

AQUATIC AND MARSH PLANTS (open water — 89 acres)

Aquatic and marsh plants are fairly common in the artificial lakes and ponds, although the abundance of submerged plants is limited by poor light penetration due to turbidity or stain. Elsewhere both aquatic and marsh plants are uncommon because of the heavy shading of most of the waters by trees, the swiftness of the river and the brooks, and the impermanence of water in the shallow flood plain runs. Most of the species are indicators of soft or acid water. The following list contains all of the species that have been found. Those preceded by an asterisk have been introduced and became established since the beginning of the study.

LAKES (including pond below Cash Lake dam)

Typha latifolia
Sparganium americanum
Potamogeton berchtoldi
Potamogeton diversifolius
Potamogeton epihydrus
Sagittaria pubescens
*Vallisneria americana
Panicum verrucosum
*Zizania aquatica
*Zizania latifolia

Dulichium arundinaceum
Eleocharis acicularis
Eleocharis obtusa
*Eleocharis palustris
*Eleocharis quadrangulata
*Scirpus acutus
*Scirpus americanus
Scirpus cyperinus
Scirpus purshianus
*Scirpus validus
Carex crinita
Pontederia cordata
Juncus effusus
Polygonum punctatum
Polygonum hydropiperoides
Nuphar advena
Nymphaea odorata
*Brasenia schreberi
Ludvigia palustris
Lindernia anagallidea
Utricularia geminiscapa
Utricularia vulgaris
Bidens frondosa

GRAVEL PIT PONDS AND EXPERIMENTAL PLANT PONDS

Typha latifolia
Sparganium americanum
Potamogeton diversifolius
Sagittaria latifolia
Alisma plantago-aquatica
*Zizania aquatica
*Zizania latifolia
Eleocharis acicularis
Eleocharis obtusa
*Eleocharis palustris
*Eleocharis quadrangulata
Fimbristylis autumnalis
*Scirpus acutus
*Scirpus americanus
Scirpus cyperinus
Scirpus purshianus
*Scirpus validus
Pontederia cordata
Heteranthera reniformis
*Iris pseudacorus
Nuphar advena
Nymphaea odorata
*Brasenia schreberi
Callitriche heterophylla
Utricularia geminiscapa
Utricularia gibba

BOTTOMLAND POOLS AND RUNS, AND BROOKS

Isoetes engelmanni
Sparganium americanum
Potamogeton epihydrus
Sagittaria latifolia
Alisma plantago-aquatica
Glyceria pallida
Glyceria septentrionalis
Orontium aquaticum
Polygonum hydropiperoides
Nuphar advena
Ranunculus ambigens
Callitriche heterophylla
Ludvigia palustris
Proserpinaca palustris
Myosotis laxa
Gratiola virginiana
Utricularia geminiscapa

PATUXENT RIVER

Potamogeton epihydrus
Podostemum ceratophyllum

FLOOD PLAIN SUCCESSIONS

1. *Marsh-meadow* (8 acres).— Marsh-meadow represents the first stage in succession on the flood plain of the Patuxent River and on the flood plains of some of the smaller streams flowing into the river. It also occurs in a narrow, interrupted fringe along the shores of the lakes and along and in the shallower ponds. Several marsh-meadows have originated in the drowning out of other flood plain communities. The areas in marsh-meadow at the present time are small and widely scattered. The characteristic species are as follows:

*Primary**

Leersia oryzoides
Polygonum sagittatum

* "Primary" and "secondary" as used in this and succeeding lists indicate relative abundance.

*Secondary**

Sagittaria pubescens	Glyceria obtusa
Echinochloa crusgalli	Cyperus erythrorhizos
Glyceria canadensis	Cyperus odoratus
Dulichium arundinaceum	Polygonum persicaria
Scirpus cyperinus	Hypericum virginicum
Scirpus polyphyllus	Viola lanceolata
Carex lurida	Ludvigia palustris
Juncus acuminatus	Proserpinaca palustris
Juncus canadensis	Eupatorium perfoliatum
Juncus effusus	Eupatorium purpureum
Polygonum pensylvanicum	Bidens frondosa

2. *Shrub Swamp* (53 acres).—Two types of shrub swamp succeed marsh-meadow. Differences between these two types are correlated with differences in their sources of water.

— One type is usually situated near running water and depends upon overflow from the stream-beds for its water supply. A nearly pure growth of Alder (*Alnus serrulata*) characterizes sites on ground usually covered with a very thin sheet of water (less than one or two inches). These Alder swamps are ordinarily rapidly invaded by River Birch (*Betula nigra*) and occasionally by Black Willow (*Salix nigra*) which form nearly pure, dense stands which eventually crowd the Alder out. In small, semi-shaded marsh-meadows within the flood plain forests, dense stands of River Birch sometimes become established by direct invasion without the intervention of the shrub swamp stage. A few shrub swamps in areas with deeper water are made up predominantly of Buttonbush (*Cephalanthus occidentalis*). Here the first tree invaders are usually either Pin Oak (*Quercus palustris*) or Overcup Oak (*Quercus lyrata*). Most of the birch and oak stands are followed directly by the river swamp stage. In a few of the birch stands, however, where the alluvium is more rapidly built up, a forest resembling bottomland forest follows. This is especially noticeable on alluvial fans formed by small streams where they enter the flood plain of the river.

The other major type of shrub swamp is generally located along the highland site of the flood plain on water-logged soil near springs. The seepage from the springs serves as their main source of water, although they are also fed from river overflow during high floods. This type of shrub swamp or "shrub bog" is characterized by a much greater variety of plants than the other. Tussocks of *Carex stricta* and a dense mat of sphagnum moss are characteristic features. Red Maple (*Acer rubrum*) is the only common tree invader. The characteristic species of this type of shrub swamp are as follows:

TREES (saplings)

Primary	*Secondary*
Acer rubrum	Salix nigra
	Quercus lyrata
	Quercus palustris

SHRUBS

Primary	*Secondary*
Alnus serrulata	Lindera benzoin
Magnolia virginiana	Aronia arbutifolia
Rosa palustris	Amelanchier canadensis
Toxicodendron vernix	Ilex verticillata
Clethra alnifolia	Leucothoe racemosa
Rhododendron viscosum	Lyonia ligustrina
Cephalanthus occidentalis	Vaccinium corymbosum
Viburnum nudum (local)	Viburnum dentatum

HERBS

Primary	*Secondary* (continued)
Dryopteris thelypteris	Carex bullata
Osmunda cinnamomea	Carex folliculata
Carex stricta	Carex incomperta
Symplocarpus foetidus	Carex laevivaginata
Rubus hispidus	Arisaema triphyllum
	Maianthemum canadense
Secondary	Polygonum arifolium
Woodwardia areolata	Polygonum sagittatum
Woodwardia virginica	Hypericum virginicum
Panicum microcarpon	Viola cucullata
Panicum verrucosum	Cicuta maculata
Glyceria striata	

3. *Transition Swamp* (78 acres).—The shrub swamps which are fed by springs ("shrub bogs") gradually change into transition swamps, with the development of a canopy of trees. In this canopy Red Maple (*Acer rubrum*) maintains its importance as the most abundant species for a considerable time. The shrub layer persists in transition swamps, although the number of species is usually reduced. The characteristic plants of transition swamps are as follows:

TREES

Primary	*Secondary*
Quercus palustris	Salix nigra
Liquidambar styraciflua	Quercus bicolor
Acer rubrum	Quercus lyrata
	Nyssa sylvatica

SHRUBS AND VINES

Primary	*Secondary* (continued)
Magnolia virginiana	Toxicodendron vernix
Lindera benzoin (local)	Clethra alnifolia
Ilex verticillata	Rhododendron viscosum
Viburnum dentatum	Leucothoe racemosa
	Lyonia ligustrina
Secondary	Cephalanthus occidentalis
Alnus serrulata	Viburnum nudum
Toxicodendron radicans	

HERBS

Primary

Osmunda cinnamomea	Symplocarpus foetidus
Carex stricta	Rubus hispidus

SECONDARY

Woodwardia areolata	Orontium aquaticum
Dryopteris cristata	Maianthemum canadense
Carex crinita	Polygonum arifolium
Carex lupulina	Polygonum punctatum
Carex squarrosa	Viola cucullata
Carex typhina	Lobelia cardinalis

4. *River Swamp* (164 acres).—The final stage of succession on poorly drained portions of the flood plain is represented by river swamp. In the succession of seepage-fed sites, transition swamp gradually changes into river swamp through the reduction and eventual loss of the shrub layer and a change in the species of trees forming the canopy. In the succession on flood-fed sites the dense stands of small birch or oaks gradually thin out as the trees grow larger; and the composition of the forest becomes more varied as new species invade it. Pin Oak (*Quercus palustris*) is the most characteristic species in river swamp, since it is found commonly throughout. Certain areas of river swamp are located on land that is covered with a considerable amount of surface water through most of the year, and there Overcup Oak (*Quercus lyrata*) usually is dominant. Other areas have little or no surface water, except during floods, and in such locations Red Maple (*Acer rubrum*), Sweetgum (*Liquidambar styraciflua*), and Red Ash (*Fraxinus pennsylvanica*) are prevalent. Throughout much of the latter type occur small "islands" or hummocks of bottomland forest. The characteristic species of river swamps are as follows:

TREES

Primary	*Secondary*
Betula nigra	Salix nigra
Quercus lyrata (local)	Quercus bicolor
Quercus palustris	Quercus phellos
Liquidambar styraciflua	Nyssa sylvatica
Acer rubrum	
Fraxinus pennsylvanica	

SHRUBS AND VINES

Primary	*Secondary*
Toxicodendron radicans	Cephalanthus occidentalis

HERBS

Primary	*Secondary* (continued)
Cinna arundinacea	Habenaria flava
Boehmeria cylindrica	Pilea pumila
Aster vimineus	Polygonum arifolium
	Tovara virginiana
Secondary	Ranunculus hispidus
Glyceria striata	Chelone glabra
Carex crinita	Lobelia cardinalis
Carex lupulina	

5. *Bottomland Forest* (472 acres).—Through the gradual deposition of alluvial materials a large part of the flood plain of the Patuxent River is well above the normal water table and, therefore, is quite well drained. This type of soil supports a very luxuriant vegetation. The composition of bottomland forest is extremely varied, slight differences in elevation accounting for striking differences in the vegetation of localities only a few feet apart. The herba-

ceous vegetation is particularly luxuriant and includes practically all of the "spring flowers" of the Refuge.

Bottomland forest is represented on the Refuge by all stages of development from areas that have been cut over recently to others that approximate the original, virgin bottomland forest. These mature stands, which are found only on some of the islands within the river drainage system, probably represent the physiographic flood plain climax for the region. Beech (*Fagus grandifolia*) predominates in all of the mature stands, where it comprises over 75% of the overstory. Other species associated with Beech in much smaller numbers include Tulip-tree (*Liriodendron tulipifera*), Northern Red Oak (*Quercus borealis*), and Sweetgum (*Liquidambar styraciflua*).

Outside these mature stands the overstory of the forest is generally composed of a considerable variety of species. Tulip-tree and Sweetgum are the only ones that sometimes occur in small, nearly pure stands. Sweetgum is the principal pioneer on well-drained flood plain land that has been retired from cultivation.

The characteristic plants of bottomland forest are as follows:

TREES

Primary
Carpinus caroliniana
Betula nigra
Fagus grandifolia
Quercus palustris
Quercus prinus (local)
Ulmus americana
Liriodendron tulipifera
Liquidambar styraciflua
Acer rubrum

Primary (continued)
Nyssa sylvatica (local)
Fraxinus americana

Secondary
Quercus borealis
Asimina triloba
Platanus occidentalis
Cornus florida

SHRUBS AND VINES

Primary
Lindera benzoin
Toxicodendron radicans
Viburnum prunifolium

Secondary
Corylus americana
Parthenocissus quinquefolia
Vitis aestivalis

HERBS

Primary
Arisaema triphyllum
Erythronium americanum
Laportea canadensis
Claytonia virginica
Ranunculus abortivus
Popophyllum peltatum
Impatiens biflora
Viola affinis
Circaea quadrisulcata
Cryptotaenia canadensis
Galium aparine

Secondary
Botrychium virginianum
Poa sylvestris
Festuca obtusa
Carex convoluta

Secondary (continued)
Uvularia sessilifolia
Allium vineale
Stellaria longifolia
Stellaria pubera
Ranunculus recurvatus
Anemonella thalictroides
Dentaria laciniata
Geum canadense
Amphicarpa bracteata
Geranium maculatum
Viola pensylvanica
Panax trifolium
Mertensia virginica
Collinsonia canadensis
Galium triflorum
Aster divaricatus
Rudbeckia laciniata

SUCCESSION ON POORLY DRAINED LAND ON TERRACE AND UPLAND

1. *Wet Meadow* (8 acres).—Certain areas of formerly cultivated fields scattered throughout the Refuge are nearly level and have a compact clay subsoil. This results in abundant moisture being confined in the surface soil. Characteristic pioneers are *Cyperus strigosus* and *Fimbristylis autumnalis*. These are succeeded by a great variety of wet meadow plants. The growth is much the same whether the fields are on terrace or upland. Many of the meadows, especially those located on the upland, are within the seepage area of springs. Characteristic wet meadow species are as follows:

Primary

Panicum dichotomiflorum
Panicum longifolium
Cyperus strigosus
Carex lurida
Carex scoparia
Juncus effusus
Viola sagittata
Rhexia mariana
Solidago graminifolia

Secondary

Onoclea sensibilis
Selaginella apoda
Panicum microcarpon
Panicum scoparium
Echinochloa crusgalli
Setaria geniculata
Agrostis alba
Calamagrostis cinnoides
Cyperus flavescens
Cyperus rivularis
Eleocharis tenuis
Fimbristylis autumnalis
Scirpus atrovirens
Scirpus cyperinus
Scirpus polyphyllus
Rhynchospora capitellata
Carex albolutescens
Carex longii
Juncus acuminatus
Juncus canadensis
Juncus marginatus
Juncus scirpoides
Juncus secundus
Juncus tenuis
Sisyrinchium graminoides
Polygonum pensylvanicum
Polygonum punctatum
Thalictrum polygamum
Linum striatum
Polygala sanguinea
Hypericum canadense
Hypericum mutilum
Viola lanceolata
Viola primulifolia
Rhexia virginica
Ludvigia alternifolia
Oenothera fruticosa
Cicuta maculata
Lysimachia terrestris
Gentiana clausa
Asclepias pulchra
Scutellaria integrifolia
Pycnanthemum flexuosum
Pycnanthemum muticum
Gratiola neglecta
Gerardia purpurea
Houstonia caerulea
Lobelia puberula
Vernonia noveboracensis
Eupatorium perfoliatum
Eupatorium purpureum
Aster puniceus
Bidens connata
Bidens frondosa

2. *Sweetgum Field* (47 acres).—Typical wet meadows rapidly change into sweetgum fields with the establishment of scattered growth of saplings or small trees of Sweetgum (*Liquidambar styraciflua*). Where seepage occurs on sandy upland Pitch Pine (*Pinus rigida*) frequently takes the place of Sweetgum in being the most important pioneer. Characteristic species of typical sweetgum fields are as follows:

TREES (saplings and small trees)

Primary
Liquidambar styraciflua

Secondary
Pinus rigida

Secondary (continued)
Pinus virginiana
Juniperus virginiana
Quercus palustris
Acer rubrum

SHRUBS AND VINES

Primary
Dewberries (Rubus spp.)

Secondary
Smilax glauca
Spiraea tomentosa

Secondary (continued)
Rhus copallina
Lyonia ligustrina
Vaccinium corymbosum
Campsis radicans

HERBS

Primary
Sorghastrum nutans (local)
Juncus effusus (local)
Potentilla simplex
Solidago altissima
Solidago graminifolia
Solidago rugosa

Secondary
Onoclea sensibilis
Botrychium dissectum
Selaginella apoda
Andropogon virginicus
Paspalum pubescens
Panicum lindheimeri
Triodia flava
Rhynchospora capitellata
Carex scoparia
Juncus tenuis
Rumex acetosella
Rubus hispidus

Secondary (continued)
Apios americana
Viola lanceolata
Viola primulifolia
Viola sagittata
Oenothera fruticosa
Gentiana clausa
Apocynum cannabinum
Asclepias pulchra
Pycnanthemum flexuosum
Gerardia purpurea
Lobelia puberula
Vernonia noveboracensis
Eupatorium album
Eupatorium pubescens
Eupatorium purpureum
Solidago juncea
Solidago nemoralis
Aster lateriflorus
Aster vimineus
Gnaphalium obtusifolium

3. *Immature Seepage Swamp* (45 acres).—With the increase in numbers and size of Sweetgum (*Liquidambar styraciflua*) and the invasion of other species of trees and shrubs, sweetgum fields change into rather dense thickets. These changes take place so rapidly and on such a variety of sites that it is seldom that two different areas can be found in the same state of development. Characteristic plants of immature seepage swamps are as follows:

TREES

Primary
Liquidambar styraciflua

Secondary
Pinus rigida
Salix nigra

Secondary (continued)
Populus grandidentata
Quercus palustris
Quercus phellos
Acer rubrum

SHRUBS AND VINES

Primary
Smilax glauca
Vaccinium corymbosum

Secondary
Salix humilis
Alnus serrulata
Rhus copallina
Lyonia ligustrina

HERBS

Primary	*Secondary*
none	Selaginella apoda
	Rubus hispidus
	Gentiana clausa
	Eupatorium pubescens

4. *Seepage Swamp* (171 acres).—Immature seepage swamps become seepage swamps with approaching maturity of the overstory. Red Maple (*Acer rubrum*) and Blackgum (*Nyssa sylvatica*) are the most characteristic trees in the more mature seepage swamps. In some sandy areas Pitch Pine (*Pinus rigida*) predominates, sometimes forming nearly pure stands. Small drainage flats below springs occur along some of the upland streams and support a type of seepage swamp which somewhat resembles bottomland forest in general appearance. Here Tulip-tree (*Liriodendron tulipifera*) is a common species. The presence of a fairly dense understory of shrubs is a feature of most seepage swamps. Characteristic seepage swamp plants are as follows:

TREES

Primary	*Secondary*
Pinus rigida	Populus grandidentata
Quercus phellos	Betula nigra
Liriodendron tulipifera (local)	Quercus alba
Liquidambar styraciflua	Quercus palustris
Ilex opaca	
Acer rubrum	
Nyssa sylvatica	

SHRUBS AND VINES

Primary	*Secondary* (continued)
Smilax rotundifolia	Toxicodendron radicans
Magnolia virginiana	Ilex verticillata
Clethra alnifolia	Evonymus americanus
Rhododendron viscosum	Kalmia angustifolia
Leucothoe racemosa	Lyonia mariana
Lyonia ligustrina	Gaylussacia frondosa
	Vaccinium corymbosum
Secondary	Chionanthus virginica
Smilax glauca	Viburnum dentatum
Aronia arbutifolia	Viburnum nudum

HERBS

Primary	*Secondary* (continued)
Woodwardia areolata	Carex debilis
Athyrium asplenioides	Carex incomperta
Osmunda cinnamomea	Carex intumescens
Lycopodium flabelliforme	Carex lupulina
Carex folliculata (local)	Carex rosea
Carex lurida (local)	Carex stricta
Rubus hispidus	Symplocarpus foetidus
	Maianthemum canadense
Secondary	Medeola virginiana
Polystichum acrostichoides	Goodyera pubescens
Dennstaedtia punctilobula	Tipularia discolor
Lycopodium obscurum	Mitchella repens

SUCCESSION ON WELL-DRAINED LAND ON TERRACE AND UPLAND

1. *Fallow Field* (Area of fallow field not determined separately from that of cultivated fields).—Recently cultivated land occurs on the upland as well as on the terraces along the Patuxent valley. The soils of the terrace fields are noticeably more sandy than elsewhere, and this is reflected in differences in vegetation. Characteristic of fallow fields (including fallow roadsides and yards) is the great variety of weedy species, of which the most common are as follows:

Primary

Digitaria ischaemum
Panicum lindheimeri
Aristida dichotoma
Aristida longespica
Ornithogalum umbellatum (local)
Rumex acetosella
Polygonum pensylvanicum
Chenopodium album
Amaranthus hybridus
Draba verna
Barbarea verna
Dewberries (Rubus spp.)
Oenothera biennis
Plantago lanceolata
Diodia teres
Erigeron canadensis
Gnaphalium obtusifolium
Ambrosia elatior

Secondary

Andropogon virginicus
Digitaria sanguinalis
Paspalum laeve
Paspalum pubescens
Paspalum setaceum
Panicum dichotomiflorum
Panicum philadelphicum
Setaria lutescens
Muhlenbergia schreberi
Sporobolus vaginiflorus
Agrostis alba
Agrostis hyemalis
Agrostis perennans
Aira caryophyllea
Holcus lanatus
Triodia flava
Eragrostis cilianensis
Cyperus ovularis
Cyperus strigosus
Bulbostylis capillaris
Juncus tenuis
Allium vineale
Rumex crispus
Rumex obtusifolius
Polygonum persicaria
Mollugo verticillata
Stellaria media
Cerastium viscosum
Dianthus armeria
Sisymbrium thalianum
Barbarea vulgaris
Potentilla monspeliensis
Potentilla simplex
Cassia fasciculata
Cassia nictitans
Crotalaria sagittalis
Trifolium agrarium
Trifolium arvense
Trifolium dubium
Trifolium hybridum
Trifolium pratense
Trifolium procumbens
Trifolium repens
Medicago lupulina
Lespedeza stipulacea
Lespedeza striata
Oxalis stricta
Euphorbia corollata
Euphorbia maculata
Hypericum gentianoides
Hypericum mutilum
Daucus carota
Trichostema dichotomum
Solanum carolinense
Linaria canadensis
Plantago aristata
Plantago rugelii
Plantago virginica
Solidago altissima
Solidago graminifolia
Solidago juncea
Solidago nemoralis
Aster pilosus
Aster vimineus
Erigeron annuus
Erigeron strigosus
Gnaphalium purpureum
Bidens frondosa
Achillea millefolium
Anthemis arvensis
Lactuca canadensis

2. *Abandoned Field* (57 acres).—Within two or three years after abandonment Broomsedge (*Andropogon virginicus*) begins to appear in most fallow fields. It soon becomes dominant and maintains dominance until it is crowded out by invading pines. In this study the term "Abandoned Field" is used only to designate this stage of succession. The co-dominance of certain goldenrods (*Solidago* spp.) and one aster (*Aster pilosus*) is another characteristic of abandoned fields. On sterile slopes Little Bluestem (*Andropogon scoparius*) sometimes takes the place of Broomsedge in becoming the chief dominant. Such areas appear to have been cleared for a much longer time and to be changing much more slowly than the typical fields. The characteristic species of abandoned fields are as follows:

Primary

Andropogon scoparius (local)
Andropogon virginicus
Danthonia spicata (local)
Dewberries (Rubus spp.)
Daucus carota
Solidago altissima
Solidago juncea
Solidago nemoralis
Aster pilosus
Achillea millefolium
Chrysanthemum leucanthemum

Secondary

Andropogon elliottii
Paspalum laeve
Paspalum pubescens
Paspalum setaceum
Panicum anceps
Panicum clandestinum
Panicum lindheimeri
Panicum polyanthes
Setaria geniculata
Anthoxanthum odoratum
Agrostis alba
Holcus lanatus
Triodia flava
Eragrostis spectabilis
Poa compressa
Poa pratensis
Bromus commutatus
Cyperus filiculmis
Cyperus ovularis
Carex annectens
Carex complanata
Carex vulpinoidea
Smilax glauca
Rumex acetosella
Dianthus armeria
Fragaria virginiana
Potentilla pumila
Potentilla simplex
Desmodium ciliare
Desmodium dillenii
Desmodium laevigatum
Desmodium marilandicum
Desmodium paniculatum
Desmodium viridiflorum
Lespedeza capitata
Lespedeza cuneata
Lespedeza repens
Lespedeza virginica
Oxalis stricta
Polygala curtissii
Euphorbia corollata
Ascyrum hypericoides
Lechea racemulosa
Trichostema dichotomum
Prunella vulgaris
Lobelia inflata
Eupatorium album
Eupatorium hyssopifolium
Eupatorium pubescens
Eupatorium verbenaefolium
Liatris graminifolia
Chrysopsis mariana
Solidago erecta
Solidago graminifolia
Solidago puberula
Solidago rugosa
Aster vimineus
Sericocarpus linifolius
Antennaria neglecta
Antenaria parlinii
Gnaphalium obtusifolium
Hieracium gronovii

3. *Pine Field* (121 acres).—The establishment of a scattered growth of saplings or small trees of pine in an abandoned field initiates the pine field stage. Both Virginia Pine (*Pinus virginiana*) and Pitch Pine (*Pinus rigida*)

invade Broomsedge (*Andropogon virginicus*) fields, the former usually in much greater abundance. Locally, however, and especially on certain moist sandy slopes, Pitch Pine is the predominating species. Black Locust (*Robinia pseudoacacia*) sometimes invades abandoned fields much as the pines do, although never on a large scale. Sweetgum (*Liquidambar styraciflua*) is a fairly common associate of the pines, especially in some of the moister terrace fields. The characteristic species of pine fields are as follows:

TREES (saplings and small trees)

Primary	*Secondary*
Pinus rigida (local)	Liquidambar styraciflua
Pinus virginiana	Robinia pseudoacacia

SHRUBS AND VINES

Primary	*Secondary*
Dewberries (Rubus spp.)	Smilax glauca
Rhus copallina (local)	Campsis radicans

HERBS

Primary	*Secondary* (continued)
Andropogon scoparius (local)	Ascyrum hypericoides
Andropogon virginicus	Hypericum gentianoides
Solidago altissima	Lechea racemulosa
Solidago juncea	Daucus carota
Solidago nemoralis	Apocynum cannabinum
Aster pilosus	Trichostema dichotomum
Achillea millefolium	Lobelia inflata
Chrysanthemum leucanthemum	Eupatorium album
	Eupatorium hyssopifolium
Secondary	Eupatorium pubescens
Andropogon elliottii	Eupatorium verbenaefolium
Paspalum pubescens	Liatris graminifolia
Panicum lindheimeri	Chrysopsis mariana
Triodia flava	Solidago erecta
Aletris farinosa	Solidago graminifolia
Spiranthes gracilis	Solidago puberula
Rumex acetosella	Solidago rugosa
Dianthus armeria	Sericocarpus asteroides
Fragaria virginiana	Sericocarpus linifolius
Potentilla pumila	Antennaria neglecta
Potentilla simplex	Antennaria parlinii
Lespedeza virginica	Gnaphalium obtusifolium
Oxalis stricta	Hieracium gronovii
Polygala curtissii	

4. *Pine Stand* (183 acres).—Pine fields become pine stands when the canopy becomes closed through increase in numbers and size of the pine. The variety of plants is usually rather limited. Reproduction underneath the canopy is almost entirely of deciduous species, with Southern Red Oak (*Quercus falcata*) generally predominating in the stands on the upland. The characteristic species of pine stands are as follows:

TREES

Primary	*Secondary*
Pinus rigida (local)	Quercus falcata
Pinus virginiana	Ilex opaca

SHRUBS AND VINES

Primary	*Secondary*
Smilax glauca (local)	Vaccinium stamineum
	Vaccinium vacillans

HERBS

Primary	*Secondary*
Lycopodium flabelliforme (local)	Pteridium aquilinum
Chimaphila maculata	Cypripedium acaule
	Mitchella repens
	Sericocarpus asteroides

5a. *Pine-Beech Forest* (9 acres). Through the growth and development of the understory of deciduous trees, pine stands on the terraces and on steep north slopes and in deep ravines of the upland gradually change into pine-beech forest. Beech (*Fagus grandifolia*) is the predominant deciduous tree, and it is mingled with pines throughout. A variation of this stage of succession with White Oak (*Quercus alba*) common, indicating the connection with the succeeding terrace and bluff forests, has not been found on the Refuge. Characteristic plants of pine-beech forest are as follows:

TREES

Primary	*Secondary*
Pinus rigida	Pinus echinata
Pinus virginiana	Liquidambar styraciflua
Fagus grandifolia	Acer rubrum
Ilex opaca	Nyssa sylvatica

SHRUBS

Primary	*Secondary*
none	Evonymus americanus
	Vaccinium vacillans

HERBS

Primary	*Secondary*
Dryopteris noveboracensis	Lycopodium obscurum
Lycopodium flabelliforme	Smilacina racemosa
Leersia virginica	Goodyera pubescens
Carex swanii	Tipularia discolor
Medeola virginiana	Pyrola rotundifolia
	Mitchella repens

5b. *Pine-Oak Forest* (234 acres). — The pine stands on the upland gradually change into pine-oak forest with the growth and development of Southern Red Oak (*Quercus falcata*) and other oaks. Quite a large proportion of the pine-oak forest is found on rather sterile, moist slopes and has an abundance of Pitch Pine (*Pinus rigida*). This type of pine-oak forest apparently develops into the final upland oak stage very slowly, and in some of the more sterile sites may be regarded as a subclimax. The characteristic plants of the pine-oak forest are as follows:

TREES

Primary	*Secondary* (continued)
Pinus rigida	Quercus alba
Pinus virginiana	Quercus coccinea
Quercus falcata	Quercus marilandica
	Quercus montana
Secondary	Quercus stellata
Pinus echinata	Amelanchier arborea

SHRUBS

Primary
Kalmia latifolia (local)
Gaylussacia baccata
Gaylussacia frondosa
Vaccinium vacillans

Secondary
Lyonia mariana
Vaccinium stamineum

HERBS

Primary
none

Secondary
Lycopodium flabelliforme
Cypripedium acaule
Tephrosia virginiana

Secondary (continued)
Chimaphila maculata
Chimaphila umbellata
Pyrola rotundifolia
Monotropa uniflora
Epigaea repens

6a. *Beech-White Oak Forest* (TERRACE FOREST, 154 acres).—Terrace forest follows pine-beech forest on the river terraces, as the final stage of succession. Beech (*Fagus grandifolia*) and White Oak (*Quercus alba*) dominate the overstory, and they may be found as single dominants or mixed together in different parts of the forest. One small mature stand of terrace forest which apparently has never been cut over is still in existence on the Refuge. The overstory of this stand is composed entirely of Beech, which presumably represents the climax of development of the terrace forest. A few "islands" of terrace forest occur within extensive areas of river swamp. Tuliptree (*Liriodendron tulipifera*) and Swamp Chestnut Oak (*Quercus prinus*) are common along the margins of these "islands." Characteristic species of terrace forest are as follows:

TREES

Primary
Fagus grandifolia
Quercus alba

Secondary
Pinus rigida
Pinus virginiana
Carya glabra
Carya tomentosa

Secondary (continued)
Quercus borealis
Quercus falcata
Quercus velutina
Liquidambar styraciflua
Amelanchier arborea
Ilex opaca
Acer rubrum
Cornus florida

SHRUBS AND VINES

Primary
none

Secondary
Smilax glauca
Toxicodendron radicans

Secondary (continued)
Evonymus americanus
Parthenocissus quinquefolia
Rhododendron nudiflorum
Gaylussacia frondosa
Vaccinium vacillans
Viburnum acerifolium

HERBS

Primary
Dryopteris noveboracensis
Leersia virginica
Carex swanii
Medeola virginiana

Secondary
Agrostis perennans
Uniola laxa
Carex abscondita

Secondary (continued)
Luzula echinata
Dioscorea quaternata
Isotria verticillata
Goodyera pubescens
Tipularia discolor
Chimaphila maculata
Pyrola rotundifolia
Monotropa uniflora
Epifagus virginiana

6a. *Beech-White Oak Forest* (BLUFF FOREST, 64 acres).—A forest type occurs on some of the steep north slopes of the upland adjacent to the flood plain, as well as in some of the deeper ravines, which closely resembles terrace forest. As in the terrace forest, the two dominant species of trees are Beech (*Fagus grandifolia*) and White Oak (*Quercus alba*). Bluff forest is somewhat better drained than terrace forest and the herbaceous vegetation is noticeably sparser. Characteristic plants of bluff forest are as follows:

TREES

Primary
Fagus grandifolia
Quercus alba

Secondary
Quercus borealis
Quercus falcata
Amelanchier arborea
Acer rubrum
Cornus florida

SHRUBS AND VINES

Primary
none

Secondary
Smilax glauca
Toxicodendron radicans

Secondary (continued)
Parthenocissus quinquefolia
Rhododendron nudiflorum
Gaylussacia frondosa
Vaccinium vacillans
Viburnum acerifolium

HERBS

Primary
none

Secondary
Medeola virginiana
Dioscorea quaternata
Goodyera pubescens

Secondary (continued)
Tipularia discolor
Desmodium nudiflorum
Chimaphila maculata
Pyrola rotundifolia
Monotropa uniflora
Epifagus virginiana

6b. *Upland Oak Forest* (297 acres).—Upland oak forest represents the final stage of succession throughout most of the upland. Various species of oaks predominate, and, locally, hickories are common. Such xerophytic species as Post Oak (*Quercus stellata*) and Blackjack Oak (*Quercus marilandica*) are generally restricted to dry sandy areas. Chestnut Oak (*Quercus montana*) is commonly found only near the tops of some of the higher hills. Other species of oak are found more regularly throughout. A few areas of upland oak forest have been cut over recently, resulting in a dense second growth of oak sprouts. The characteristic species of upland oak forest are as follows:

TREES

Primary
Quercus alba
Quercus coccinea
Quercus velutina

Secondary
Pinus virginiana
Populus grandidentata
Carya glabra

Secondary (continued)
Carya tomentosa
Castanea dentata (sprouts)
Quercus falcata
Quercus marilandica
Quercus montana
Quercus stellata
Amelanchier arborea

SHRUBS

Primary	*Secondary*
Rhododendron nudiflorum	Castanea pumila
Kalmia latifolia (local)	Lyonia mariana
Gaylussacia baccata	Vaccinium stamineum
Gaylussacia frondosa	
Vaccinium vacillans	

HERBS

Primary	*Secondary*
none	Tephrosia virginiana
	Chimaphila maculata
	Pyrola rotundifolia
	Monotropa uniflora
	Epigaea repens

HEDGEROWS AND WOOD MARGINS (95 acres)

Hedgerows. Many of the fields on the Refuge are bordered or dissected by hedgerows which are dominated by a variety of trees having a dense undergrowth of shrubs and woody vines. The composition of the hedgerows varies considerably from place to place, depending on the relative age or development of the hedgerow and the amount of moisture in the ground. Characteristic plants are as follows:

TREES

Primary	*Secondary*
Sassafras albidum	Salix nigra
Liquidambar styraciflua	Quercus palustris
Prunus serotina	Quercus phellos
Diospyros virginiana	Robinia pseudoacacia
	Acer rubrum

SHRUBS AND VINES

Primary	*Secondary* (continued)
Smilax glauca	Rosa carolina
Smilax rotundifolia	Rhus glabra
Highbush blackberries (Rubus spp.)	Toxicodendron radicans
Rhus copallina	Parthenocissus quinquefolia
Lonicera japonica	Vitis aestivalis
	Vitis labrusca
Secondary	Vitis vulpina
Salix humilis	Campsis radicans
Corylus americana	Viburnum dentatum
Alnus serrulata	Sambucus canadensis
Aronia arbutifolia	

HERBS

Primary	*Secondary* (continued)
none	Potentilla simplex
	Apios americana
Secondary	Veronica officinalis
Panicum clandestinum	Eupatorium purpureum
Panicum polyanthes	Solidago graminifolia
Agrostis perennans	Solidago rugosa

Wood Margins. A type of vegetation very similar in composition to that of hedgerows is found along the edges of woods and along wood roads and in other small openings within the forest. As a rule, wood margins located

on damp sites have a considerably more luxuriant vegetation than do those on drier sites. Sassafras (*Sassafras albidum*), Black Cherry (*Prunus serotina*), and Persimmon (*Diospyros virginiana*) are the commonest trees throughout. River Birch (*Betula nigra*) which is prominent in wood margins of flood plain and terrace is apparently lacking in wood margins of the upland. Characteristic species are as follows:

TREES

Primary
Betula nigra (local)
Sassafras albidum
Prunus serotina
Diospyros virginiana

Secondary
Carya cordiformis
Carpinus caroliniana
Quercus palustris
Liquidambar styraciflua
Cornus florida

SHRUBS AND VINES

Primary
Smilax glauca
Smilax rotundifolia
Highbush blackberries (Rubus spp.)
Rhus copallina
Vitis aestivalis
Lonicera japonica

Secondary
Salix humilis
Corylus americana

Secondary (continued)
Alnus serrulata
Rosa carolina
Rhus glabra
Toxicodendron radicans
Vitis labrusca
Vitis vulpina
Cornus amomum
Campsis radicans
Viburnum dentatum
Sambucus canadensis

HERBS

Primary
Phytolacca americana (local)

Secondary
Pteridium aquilinum
Potentilla pumila
Desmodium dillenii
Desmodium laevigatum
Desmodium paniculatum
Acalypha rhomboidea
Ascyrum hypericoides

Secondary (continued)
Hypericum gentianoides
Lysimachia quadrifolia
Prunella vulgaris
Hedeoma pulegioides
Veronica officinalis
Solidago rugosa
Krigia virginica
Lactuca canadensis
Hieracium gronovii

CULTIVATED FIELDS AND PASTURES

Cultivated Fields (177 acres).—The cultivated fields (principal crops are corn and soybeans) and gardens are invaded by many weed species. The more characteristic of these are as follows:

Primary
Eragrostis cilianensis (local)
Cyperus esculentus (local)
Polygonum pensylvanicum
Mollugo verticillata
Ambrosia elatior

Secondary
Digitaria ischaemum
Digitaria sanguinalis
Panicum lindheimeri
Cyperus strigosus
Rumex acetosella
Polygonum persicaria

Secondary (continued)
Chenopodium album
Amaranthus hybridus
Stellaria media
Sisymbrium thalianum
Euphorbia corollata
Euphorbia maculata
Anagallis arvensis
Ipomoea lacunosa
Ipomoea purpurea
Solanum carolinense
Diodia teres
Erigeron canadensis

Pastures (32 acres).—The pastures are all permanent and are quite weedy. Most of the lawns are similar. Characteristic pasture species are as follows:

Primary	*Secondary* (continued)
Digitaria ischaemum	Juncus tenuis
Poa pratensis	Allium vineale
Cerastium viscosum	Rumex acetosella
Trifolium repens	Cerastium vulgatum
Plantago lanceolata	Potentilla canadensis
	Plantago rugelii
Secondary	Aster spp.
Andropogon virginicus	Antennaria neglecta
Panicum spp.	Krigia virginica
Agrostis alba	Hieracium gronovii

The Flora

Eight hundred and fifty-four species of ferns and flowering plants have been found on the Patuxent Research Refuge. Trees account for 64 species, shrubs and woody vines for 70. Among herbaceous plants the largest families are the grasses, with 102 species (26 of Panicum); sedges, with 82 species (52 of Carex); and composites, with 105. Other large groups are the pteridophytes (31 species), Rosaceae (38), legumes (46), heaths (24), and mints (26). All of the species listed are included in Hermann's "A checklist of plants in the Washington-Baltimore area."[10] Specimens of each species are preserved in the Refuge herbarium.

Most of the specimens of Gramineae were identified by J. R. Swallen, the few remaining by Mrs. Agnes Chase and Dr. F. J. Hermann. All *Carex* and Juncaceae were identified by Dr. F. J. Hermann. *Malus angustifolia* was identified by Dr. Rogers McVaugh; *Crataegus* by Ernest J. Palmer; specimens of six species of *Rubus* (all of the dewberries and highbush blackberries collected) by Dr. L. H. Bailey. All of the Compositae were identified by Dr. S. F. Blake. The remaining specimens were identified by the senior author.

The authors are responsible for the interpretation of the entire list in relation to Gray's Manual[11] descriptions and nomenclature. Where usage differs from that of Gray's Manual a suitable reference has been made.

A noteworthy element in the flora is the "spring flowers" of the Patuxent River bottomland forest, an area of Piedmont-derived soils in which both environmental conditions and flora resemble those of the Piedmont Plateau (see list on p. 12).

Another special group comprises species of marsh and aquatic plants that have been introduced since the beginning of this study and have established themselves. They are listed on pp. 7 & 8. A few other native plants of wet habitats have been increased through introductions.

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10 Hermann, Frederick J. 1946—A checklist of plants in the Washington-Baltimore area, 2nd edition. Washington, D. C.

11 Robinson, Benjamin Lincoln, and Fernald, Merritt Lyndon. 1908—Gray's new manual of botany (Seventh edition—illustrated). New York.

As everywhere else in long-settled, originally forested regions, open land supports many weedy species of both foreign and American origin; and the relative abundance of many other native species differs greatly from their abundance in the virgin forest.

Indicative of the interesting nature of the region is the following list of plants that have been found within one mile of the Refuge boundary but not on the Refuge: *Lycopodium adpressum* (*L. inundatum* var. *bigelovii* of Gray's Manual), *Andropogon furcatus, Panicum linearifolium, Trisetum pennsylvanicum* (*Sphenopholis palustris* of Gray's Manual), *Gymnopogon ambiguus, Carex atlantica* (*C. sterilis* of Gray's Manual), *Carex emoryi* (not treated in Gray's Manual), *Carex leptalea* var. *harperi* (*C. harperi* of Gray's Manual), *Quercus prinoides, Drosera rotundifolia, Lupinus perennis, Galactia regularis, Polygala cruciata, Polygala lutea, Viola kitaibeliana* (*V. rafinesquii* of Gray's Manual), *Gaylussacia dumosa, Pentstemon digitalis* (*P. laevigatus,* var. *digitalis* of Gray's Manual), and *Utricularia subulata.* Most of these species have been found in open gravel bogs or in dry sand. Considering the numerous small bogs, the large area of sand near Fort George G. Meade, the nearby Piedmont Plateau, and the fertile Eocene Greensand district just to the south, the Refuge region is one of unusual botanical interest.

In the following annotated list there is given for each species its relative abundance (rare, occasional, common, abundant, or very abundant) in each plant community where it has been observed. The arrangement of families and genera follows that of Gray's Manual; species are in alphabetical order within a genus.

LIST OF VASCULAR PLANTS

POLYPODIACEAE

Polypodium virginianum (Polypody). *P. vulgare* of *Gray's Manual* but not *P. vulgare* of Europe and western North America—see *Rhodora* **24**:141. 1922. Rare on tree trunks in seepage swamps.

Pteridium aquilinum var. *latiusculum* (Bracken). *Pteris aquilina* of *Gray's Manual*—see *Rhodora* **43**:41. 1941. Common in openings and along margins of upland forests; occasional in pine stands and hedgerows.

Woodwardia areolata (Net-vein Chain Fern). Common (locally abundant) in shrub swamps, transition swamps, and seepage swamps.

Woodwardia virginica (Virginia Chain Fern). Occasional in shrub swamps; rare in seepage swamps.

Asplenium platyneuron (Ebony Spleenwort). Occasional (locally common) in sweetgum fields, pine fields, and hedgerows; rare in immature seepage swamps and pine stands.

Athyrium asplenioides (Lady Fern). *Asplenium filix-femina,* in part, of *Gray's Manual*—see *Rhodora* **19**:189. 1917. Common in seepage swamps; rare in immature seepage swamps and terrace forest.

Athyrium thelypteroides (Silvery Spleenwort). *Asplenium acrostichoides* of *Gray's Manual.* One station in seepage swamp at edge of flood plain.

Polystichum acrostichoides (Christmas Fern). Occasional (locally common) in seepage swamps, along brook banks in terrace forest, and along ditches in hedgerows on terrace; rare in bottomland forest and immature seepage swamps.

Dryopteris cristata (Crested Fern). *Aspidium cristatum* of *Gray's Manual.* Occasional in transition swamps; rare in seepage swamps.

Dryopteris hexagonoptera (Beech Fern). *Phegopteris hexagonoptera* of *Gray's Manual.* Rare in terrace forest and bluff forest; one station in bottomland forest.

Dryopteris marginalis (Marginal Wood Fern). *Aspidium marginale* of *Gray's Manual.* Rare in seepage swamps.

Dryopteris noveboracensis (New York Fern). *Aspidium noveboracense* of *Gray's Manual.* Abundant in terrace forest; occasional (locally common) in hedgerows; occasional in bottomland forest, seepage swamps, pine-beech forest, and bluff forest.

Dryopteris simulata (Massachusetts Fern). *Aspidium simulatum* of *Gray's Manual.* One station in shrub swamp.

Dryopteris spinulosa var. *intermedia* (Spinulose Wood Fern). *Aspidium spinulosum* var. *intermedium* of *Gray's Manual.* Rare in seepage swamps and bluff forest.

Dryopteris thelypteris (Marsh Fern). *Aspidium thelypteris* of *Gray's Manual.* Common in open shrub swamps; rare in marsh-meadows and wet meadows.

Dennstaedtia punctilobula (Hay-scented Fern). *Dicksonia punctilobula* of *Gray's Manual.* Occasional (locally common) in seepage swamps, terrace forest, and bluff forest.

Onoclea sensibilis (Sensitive Fern). Occasional (locally common) in wet meadows, sweetgum fields, immature seepage swamps, and damp hedgerows; rare in shrub swamps and seepage swamps.

OSMUNDACEAE

Osmunda cinnamomea (Cinnamon Fern). Common (locally abundant) in shrub swamps, transition swamps, and seepage swamps; occasional in damp hedgerows.

Osmunda claytoniana (Interrupted Fern). Rare in immature seepage swamps, seepage swamps, and damp hedgerows.

Osmunda regalis var. *spectabilis* (Royal Fern). *O. regalis* of *Gray's Manual.* Occasional in shrub swamps, transition swamps, and seepage swamps.

OPHIOGLOSSACEAE

Ophioglossum vulgatum (Adders-tongue Fern). One station in sweetgum field.

Botrychium dissectum (Grape Fern). *B. obliquum* and varieties of *Gray's Manual.* Occasional in bottomland forest and sweetgum fields; rare in wet meadows, immature seepage swamps, pine fields, and hedgerows.

Botrychium virginianum (Rattlesnake Fern). Common in bottomland forest; rare in seepage swamps.

EQUISETACEAE

Equisetum arvense (Horsetail). One station in damp soil along road embankment.

LYCOPODIACEAE

Lycopodium clavatum (Running-pine). Rare in seepage swamps; one station at open edge of upland oak forest.

Lycopodium flabelliforme (Common Ground-cedar). *L. complanatum* var. *flabelliforme* of *Gray's Manual*. Common (locally abundant) in seepage swamps, pine stands, pine-beech forest, and pine-oak forest; occasional in terrace forest; rare in sweetgum fields, immature seepage swamps, and pine fields.

Lycopodium lucidulum (Shining Clubmoss). Occasional in seepage swamps and along brook banks in terrace forest.

Lycopodium obscurum (Tree Clubmoss). Occasional (locally common) in seepage swamps; occasional in pine stands, pine-beech forest, terrace forest, and pine-oak forest; rare in bluff forest and upland oak forest.

Lycopodium tristachyum (Slender Ground-cedar). Rare in pine-oak forest.

SELAGINELLACEAE

Selaginella apoda (Creeping Selaginella). *S. apus* of *Gray's Manual*. Occasional (locally common) in wet meadows, sweetgum fields, immature seepage swamps, and damp pastures.

ISOETACEAE

Isoetes engelmanni (Quillwort). Occasional (locally common) in runs on flood plain.

PINACEAE

Pinus echinata (Shortleaf Pine). Occasional in pine-beech forest and pine-oak forest; rare in terrace forest and upland oak forest.

Pinus rigida (Pitch Pine). Common (locally abundant) in seepage swamps, pine fields, pine stands, pine-beech forest, and pine-oak forest; occasional in sweetgum fields, immature seepage swamps, and terrace forest; rare in shrub swamps and upland oak forest.

Pinus strobus (White Pine). Two trees: terrace forest and pine-oak forest; possibly seeded from nearby cultivated trees.

Pinus taeda (Loblolly Pine). Three trees at one station in pine stand.

Pinus virginiana (Virginia Pine). Very abundant in pine fields and pine stands; abundant in pine-oak forest; common in pine-beech forest; occasional in sweetgum fields, terrace forest, bluff forest, and upland oak forest; rare in immature seepage swamps and hedgerows.

Juniperus virginiana (Red-cedar). Occasional in sweetgum fields, pine fields, and hedgerows; rare in river swamps, bottomland forest, seepage swamps, terrace forest, bluff forest, pine stands, pine-oak forest, and upland oak forest.

TYPHACEAE

Typha latifolia (Common Cat-tail). Occasional along shore of Cash Lake and Lake Redington and in gravel pits and other wet depressions.

SPARGANIACEAE

Sparganium americanum (Bur-reed). Includes *S. lucidum* of *Gray's Manual*. Common (locally abundant) along shore of Cash Lake; occasional in pools in runs in river swamps and in slow brooks. Accidentally established in experimental plant pond through introduction of muck soil from Cash Branch swamp.

NAJADACEAE

Potamogeton berchtoldi, *F. pusillus*, in part, of *Gray's Manual*—see *Rhodora* **42**:246. 1940. One station in pool below Cash Lake dam.

Potamogeton diversifolius. *P. hybridus*, in part, of *Gray's Manual*—see *Memoirs of the*

American Academy of Arts and Sciences **17**:105. 1932. Common in south end of Cash Lake and in one gravel pit pond; rare in experimental plant ponds.

Potamogeton epihydrus (Ribbonleaf Pondweed). Common in shallows of Cash Lake (partly, at least, because of transplantation from Glenn Dale, Prince Georges County); occasional in shallows of Patuxent River and in brooks on flood plain.

ALISMACEAE

Sagittaria latifolia (Broadleaf Arrowhead). Occasional in pools in runs in transition swamps and river swamps. Established in experimental plant pond from transplantation from tidal Potomac River.

Sagittaria pubescens (Hairy Arrowhead). *S. latifolia* var. *pubescens* of *Gray's Manual*. Common along shore of Cash Lake and in marsh-meadows elsewhere; occasional in shrub swamps.

Alisma plantago-aquatica (Water-plantain). Occasional in pools in runs in river swamps, slow brooks, and one gravel pit pond.

HYDROCHARITACEAE

Vallisneria americana (Wild-celery). *V. spiralis* of *Gray's Manual*. Established in Cash Lake from transplantation from tidal Potomac River.

GRAMINEAE

Erianthus giganteus (Plume-grass). *E. saccharoides* of *Gray's Manual*. One station in sweetgum field.

Andropogon elliottii (Elliott Beardgrass). Occasional in abandoned fields and pine fields; rare in sweetgum fields.

Andropogon glomeratus (Bushy Beardgrass). Rare in wet meadows.

Andropogon scoparius (Little Bluestem). Occasional (locally abundant) in abandoned fields and pine fields on upland.

Andropogon virginicus (Broomsedge). Very abundant in abandonded fields and pine fields; occasional (locally common) in sweetgum fields and pastures; occasional in fallow fields; rare in lawns.

Sorghastrum nutans (Indian Grass). Occasional (locally abundant) in sweetgum fields.

Digitaria filiformis (Finger-grass). Occasional in fallow fields and wood margins.

Digitaria ischaemum (Smooth Crabgrass). *D. humifusa* of *Gray's Manual*. Common (locally abundant) in fallow fields, cultivated fields, pastures, and lawns.

Digitaria sanguinalis (Hairy Crabgrass). Occasional (locally abundant) in fallow fields and cultivated fields; occasional in lawns.

Paspalum laeve. Includes *P. plenipilum* of *Gray's Manual*. Occasional in fallow fields, abandoned fields, and lawns; rare in sweetgum fields, pine fields, and hedgerows.

Paspalum pubescens. Occasional in sweetgum fields, fallow fields, abandoned fields, and pine fields.

Paspalum setaceum. Occasional in fallow fields and abandoned fields; rare in pine fields.

Panicum agrostoides. Rare in wet meadows and sweetgum fields.

Panicum anceps. Occasional in abandoned fields.

Panicum boscii. Rare in terrace forest and upland oak forest.

Panicum capillare (Common Witch-grass). Rare in fallow fields; one station in cultivated field.

Panicum clandestinum (Deer-tongue Grass). Common in hedgerows; occasional in abandoned fields; rare in sweetgum fields, fallow fields, and open terrace forest.

Panicum columbianum. Rare in upland oak forest.

Panicum commutatum. Includes *P. ashei* of *Gray's Manual.* Occasional along margins of terrace forest and upland oak forest.

Panicum depauperatum. Occasional in abandoned fields and along margins of upland oak forest.

Panicum dichotomiflorum (Fall Panicum). Common in wet meadows; occasional in fallow fields; rare in cultivated fields.

Panicum dichotomum. Includes *P. barbulatum* of *Gray's Manual.* Occasional along margins of terrace forest and upland oak forest.

Panicum gattingeri (Gattinger Witch-grass). Abundant in one cornfield.

Panicum huachucae. Occasional in wood margins; rare in pine fields.

Panicum lindheimeri. Abundant in fallow fields; occasional in sweetgum fields, abandoned fields, pine fields, open terrace forest, and cultivated fields.

Panicum longifolium. Occasional (locally common) in wet meadows; rare in sweetgum fields.

Panicum lucidum. Rare in shrub swamps.

Panicum meridionale. One station in terrace forest.

Panicum microcarpon. Occasional (locally common) in shrub swamps and wet meadows; rare in sweetgum fields, seepage swamps, terrace forest, and damp hedgerows.

Panicum philadelphicum (Philadelphia Witch-grass). Occasional in fallow fields.

Panicum polyanthes. Occasional in abandoned fields, hedgerows, and wood margins; rare in sweetgum fields and open terrace forest.

Panicum scoparium (Velvet Panicum). Occasional in wet meadows; rare in sweetgum fields.

Panicum sphaerocarpon. Occasional in fallow fields; rare in abandoned fields, pine fields, and lawns.

Panicum stipitatum. Rare in wet meadows and sweetgum fields.

Panicum tennessense. Rare in wood margins.

Panicum verrucosum (Warty Panicum). Common in south end of Lake Redington in 1946; occasional (locally common) in cleared shrub swamps; rare in fallow fields.

Panicum villosissimum. One station in wood margin on terrace.

Panicum virgatum (Switch Grass). One station in abandoned field.

Echinochloa crusgalli (Wild-millet). Abundant in 1946 along shore of Lake Redington, where it was seeded in 1945; occasional elsewhere in marsh-meadows and wet meadows; rare in fallow fields.

Setaria faberi. Not treated in *Gray's Manual*—see *Rhodora* **46**:57. 1944. Two stations: fallow field and cornfield.

Setaria geniculata. S. imberbis of *Gray's Manual.* Occasional in wet meadows and abandoned fields; rare in sweetgum fields.

Setaria lutescens (Yellow Bristle-grass). *S. glauca* of *Gray's Manual.* Occasional (locally common) in fallow fields; rare in lawns.

Setaria viridis (Green Bristle-grass). Rare in fallow fields.

Cenchrus longispinus (Sandbur). *C. carolinianus* of *Gray's Manual.* Occasional in fallow fields on terrace.

Zizania aquatica (Wild-rice). *Z. palustris* of *Gray's Manual.* Established in south end of Cash Lake from seed and in experimental plant pond from transplantation from tidal South River, Anne Arundel County.

Zizania latifolia (Asiatic Wild-rice). Not treated in *Gray's Manual*—see Hitchcock, *Manual of the grasses of the United States,* p. 540. 1935. Established in Cash Lake and one gravel pit pond from transplantations from the U. S. Department of Agriculture.

Leersia oryzoides (Rice Cut-grass). Abundant in marsh-meadows.

Leersia virginica (White Grass). Common in terrace forest; occasional in hedgerows; rare in seepage swamps.

Anthoxanthum odoratum (Vernal-grass). Occasional in abandoned fields and lawns.

Stipa avenacea (Needle-grass). Rare in terrace forest.

Aristida dichotoma. Common in fallow fields; rare in abandoned fields and pine fields.

Aristida longespica. A. gracilis of *Gray's Manual.* Common in fallow fields; rare in sweetgum fields, abandoned fields, and pine fields.

Aristida oligantha. Rare in fallow fields.

Aristida purpurascens. One station in pine field on terrace.

Muhlenbergia frondosa (Wirestem Muhly). *M. mexicana* of *Gray's Manual.* Two stations: bottomland forest and fallow field.

Muhlenbergia schreberi (Nimble-Will). Occasional in fallow fields and pastures; rare in abandoned fields and lawns.

Muhlenbergia sylvatica (Forest Muhly). One station in bottomland forest.

Brachyelytrum erectum. One plant in bottomland forest.

Phleum pratense (Timothy). Occasional along roads; rare in abandoned fields.

Sporobolus vaginiflorus (Dropseed). Occasional (locally common) in fallow fields and lawns.

Agrostis alba (Redtop). Occasional (locally common) in wet meadows, abandoned fields, and pastures; occasional in fallow fields; rare in sweetgum fields.

Agrostis hyemalis (Tickle Grass). Occasional (locally common) in fallow fields; occasional in wet meadows.

Agrostis perennans (Autumn Bent). Common in one cut-over river swamp; occasional (locally abundant) in fallow fields; occasional in terrace forests and hedgerows and along roads in upland forest.

Calamagrostis cinnoides (Reed-grass). Occasional (locally common) in wet meadows; rare in sweetgum fields.

Cinna arundinacea (Wood-reed). Abundant in river swamps; occasional in bottomland forest; rare in immature seepage swamps, terrace forest, and damp hedgerows.

Aira caryophyllea (Silver Hair-grass). Occasional in fallow fields and along roads.

Holcus lanatus (Velvet Grass). Occasional in fallow fields and abandoned fields; rare in lawns.

Sphenopholis intermedia. S. pallens of *Gray's Manual.* Occasional in bottomland forest; one station in seepage swamp.

Danthonia spicata (Poverty Oat-grass). Common in abandoned fields; rare in sweetgum fields, pine fields, and open terrace forest.

Cynodon dactylon (Bermuda Grass). Rare in fallow fields and lawns.

Eleusine indica (Goose Grass). Rare in fallow fields, cultivated fields, and lawns.

Triodia flava (Purpletop). *Tridens flavus* of *Gray's Manual.* Common in abandoned fields; occasional in sweetgum fields, fallow fields, pine fields, hedgerows, and wood margins.

Eragrostis capillaris (Lace Grass). One station in clearing in upland oak forest.

Eragrostis cilianensis (Stink Grass). *E. megastachya* of *Gray's Manual.* Common (locally abundant) in cultivated fields; occasional in fallow fields.

Eragrostis hypnoides (Teal Grass). Rare in wet meadows.

Eragrostis pectinacea (Carolina Love-grass). *E. pilosa,* in part, of *Gray's Manual*—see Hitchcock, *Manual of the grasses of the United States,* p. 151. 1935. Rare in fallow fields.

Eragrostis spectabilis (Purple Love-grass). *E. pectinacea* of *Gray's Manual.* Occasional (locally common) in abandoned fields; rare in sweetgum fields, fallow fields, pine fields, and lawns.

Uniola laxa. Occasional in terrace forest; rare in seepage swamps.

Dactylis glomerata (Orchard Grass). Occasional in orchards and along roads.

Poa annua (Annual Bluegrass). Two stations: pasture and lawn.

Poa autumnalis. Occasional in bottomland forest.

Poa compressa (Canada Bluegrass). Occasional in abandoned fields; rare in sweetgum fields, pine fields, and hedgerows.

Poa pratensis (Kentucky Bluegrass). Common (locally abundant) in pastures and lawns (persisting from seeding); occasional in abandoned fields; rare in pine fields and hedgerows.

Poa sylvestris (Woodland Bluegrass). Common in bottomland forest.

Poa trivialis (Rough Bluegrass). Occasional in bottomland forest.

Glyceria canadensis (Rattlesnake Grass). Occasional (locally common) in marsh-meadows.

Glyceria obtusa (Atlantic Manna-grass). Occasional in marsh-meadows.

Glyceria pallida (Pale Manna-grass). Rare in pools in runs in river swamps.

Glyceria septentrionalis (Eastern Manna-grass). Occasional in pools in runs in transition swamps and river swamps.

Glyceria striata (Fowl Manna-grass). *G. nervata* of *Gray's Manual.* Common in shrub swamps and river swamps.

Festuca elatior (Meadow Fescue). One station in abandoned field.

Festuca myuros (Rat-tail Fescue). Occasional in abandoned fields.

Festuca obtusa (Nodding Fescue). *F. nutans* of *Gray's Manual.* Common in bottomland forest; one station in Ailanthus thicket.

Festuca octoflora (Six-weeks Fescue). Occasional in abandoned fields and wood margins.

Bromus commutatus (Hairy Chess). Occasional (locally common) in abandoned fields.

Bromus mollis (Soft Chess). *B. hordeaceus* of *Gray's Manual.* One station in lawn.

Lolium multiflorum (Italian Rye-grass). One station in fallow field.

Lolium perenne (Perennial Rye-grass). One station in fallow field.

Agropyron repens (Quack Grass). Occasional in fallow fields.

Elymus villosus (Slender Wild-rye). *E. striatus* of *Gray's Manual.* One station in bottomland forest.

Elymus virginicus (Virginia Wild-rye). Occasional in bottomland forest; rare in hedgerows.

Hystrix patula (Bottle-brush Grass). Rare in bottomland forest.

CYPERACEAE

Cyperus erythrorhizos. Locally abundant along west shore of Lake Redington in 1946; possibly introduced with Wild-millet seed.

Cyperus esculentus (Chufa). Locally abundant in cultivated fields.

Cyperus filiculmis. Occasional in abandoned fields and wood margins; rare in sweetgum fields, fallow fields, and pine fields.

Cyperus flavescens. Occasional in wet meadows.

Cyperus odoratus. C. ferax of *Gray's Manual.* Locally abundant along west shore of Lake Redington in 1946; possibly introduced with Wild-millet seed.

Cyperus ovularis. Occasional in fallow fields and abandoned fields; rare in sweetgum fields.

Cyperus polystachyos var. *texensis. C. microdontus* of *Gray's Manual.* One station in wet meadow.

Cyperus retrorsus. C. cylindricus of *Gray's Manual.* Rare in wood margins.

Cyperus rivularis. Occasional in wet meadows.

Cyperus strigosus. Common in wet meadows and damp fallow fields; occasional (locally common) in damp cultivated fields; rare in sweetgum fields.

Kyllinga pumila. Occasional in wet meadows.

Dulichium arundinaceum. Occasional (locally common) along shore of Cash Lake and Lake Redington; occasional elsewhere in marsh-meadows.

Eleocharis acicularis (Needle Spike-rush). Abundant in Cash Lake; common in one gravel pit pond.

Eleocharis obtusa (Blunt Spike-rush). Locally abundant in south end of Lake Redington in 1946; common along shore of Cash Lake and in gravel pit ponds and experimental plant ponds.

Eleocharis palustris (Creeping Spike-rush). Established in experimental plant pond and along shore of Cash Lake from transplantations from tidal Potomac River.

Eleocharis quadrangulata (Square-stem Spike-rush). Established in Lake Redington from seed and in experimental plant pond from transplantations from tidal Patuxent River.

Eleocharis tenuis (Slender Spike-rush). Occasional (locally common) in wet meadows; rare in sweetgum fields and damp pastures.

Bulbostylis capillaris. Stenophyllus capillaris of *Gray's Manual.* Occasional in fallow fields and wood margins; rare in cultivated fields.

Fimbristylis autumnalis. Common along shores of gravel pit ponds and experimental plant ponds, and elsewhere in wet meadows and damp fallow fields.

Scirpus acutus (Hardstem Bulrush). *S. occidentalis* of *Gray's Manual.* Established in Cash Lake and experimental plant pond from transplantations from Minnesota.

Scirpus americanus (Three-square). Established in Lake Redington from seed and in experimental plant pond from transplantations from tidal Potomac River.

Scirpus atrovirens (Green Bulrush). Includes *S. georgianus* of *Gray's Manual.* Occasional in wet meadows.

Scirpus cyperinus (Wool-grass). Includes *S. eriophorum* of *Gray's Manual.* Abundant in south end of Lake Redington; occasional (locally common) along shore of Cash Lake and in gravel pit ponds; occasional in wet meadows; rare in sweetgum fields.

Scirpus polyphyllus (Leafy Bulrush). Occasional in marsh-meadows and wet meadows.

Scirpus purshianus (Weak Bulrush). *S. debilis* of *Gray's Manual.* Abundant in south end of Lake Redington in 1946; occasional (locally common) along shore of Cash Lake and in gravel pit ponds.

Scirpus validus (Softstem Bulrush). Established in south end of Cash Lake from seed and in experimental plant pond from transplantation from tidal South River, Anne Arundel County.

Rhynchospora capitellata. R. glomerata (typical) of *Gray's Manual.* Occasional (locally common) in wet meadows and sweetgum fields; rare in fallow fields.

Rhynchospora corniculata. Occasional in river swamps.

Rhynchospora globularis. R. cymosa of *Gray's Manual.* Rare in wet meadows.

Scleria pauciflora (Nut-rush). Two stations: immature seepage swamp and pine field.

Carex abscondita. C. ptychocarpa of *Gray's Manual.* Occasional in terrace forest; rare in hedgerows.

Carex aggregata. Not treated in *Gray's Manual*—see *North American Flora* **18**:61. 1931. One plant in abandoned field.

Carex albolutescens, C. albolutescens, in part, of *Gray's Manual,* which figures *C. longii* as *C. albolutescens*—see *Rhodora* **40**:330. 1938. Occasional in wet meadows.

Carex annectens. *C. setacea* var. *ambigua* of *Gray's Manual.* Includes *C. annectens* var. *xanthocarpa*—see *Rhodora* **24**:74. 1922. Occasional in abandoned fields and wood margins.

Carex blanda. *C. laxiflora* var. *blanda* of *Gray's Manual.* Three stations: bottomland forest, abandoned field, and lawn.

Carex bullata. Occasional in open shrub swamps; rare in wet meadows.

Carex canescens. Rare in open shrub swamps.

Carex caroliniana. *C. triceps* var. *smithii* of *Gray's Manual.* Occasional in wood margins on flood plain and terrace.

Carex cephalophora. Rare in terrace forest.

Carex complanata. Not treated in *Gray's Manual*—see *North American Flora* **18**:323. 1935. Occasional in abandoned fields.

Carex convoluta. *C. rosea,* in part, of *Gray's Manual,* which figures *C. convoluta* as *C. rosea*—see *North American Flora* **18**:46. 1931. Occasional (locally common) in bottomland forest; rare in terrace forest.

Carex crinita. Common in south end of Lake Redington, transition swamps, and river swamps; occasional in shrub swamps and seepage swamps.

Carex debilis. Occasional in immature seepage swamps and seepage swamps.

Carex digitalis. One station in terrace forest.

Carex emmonsii. *C. varia,* in part, of *Gray's Manual*—see *North American Flora* **18**:190. 1935. Occasional in terrace forest and damp wood margins.

Carex festucacea. Not treated in *Gray's Manual,* the *C. festucacea* described there being *C. merritt-fernaldii*—see *North American Flora* **18**:150. 1931. One station in terrace forest.

Carex folliculata. Common in shrub swamps and seepage swamps.

Carex frankii. Occasional in river swamps.

Carex glaucodea. Occasional in forest openings on terrace and upland.

Carex grayii. One station in bottomland forest.

Carex grisea. Rare in bottomland forest.

Carex hirsutella. *C. triceps* var. *hirsuta* of *Gray's Manual.* Two stations: abandoned field and hedgerow.

Carex howei. *C. scirpoides* var. *capillacea* of *Gray's Manual.* One station in seepage swamp.

Carex incomperta. *C. stellulata* var. *excelsior* of *Gray's Manual.* Common in shrub swamps and seepage swamps.

Carex intumescens. Occasional in seepage swamps.

Carex laevivaginata. Not treated in *Gray's Manual*—see *North American Flora* **18**:80. 1931. Occasional in shrub swamps.

Carex laxiculmis. Rare in bottomland forest.

Carex laxiflora. *C. laxiflora* var. *patulifolia* of *Gray's Manual.* One station in terrace forest.

Carex leavenworthii. One station in lawn.

Carex longii. *C. albolutescens*, in part, of *Gray's Manual*, which figures *C. longii* as *C. albolutescens*—see *North American Flora* **18**:161. 1931. Occasional in wet meadows.

Carex louisianica. *C. halei* of *Gray's Manual.* Rare in river swamps.

Carex lupuliformis. One station in run in river swamp.

Carex lupulina. Common in transition swamps and river swamps; occasional in seepage swamps.

Carex lurida. Common (locally abundant) in wet meadows; occasional (locally common) in marsh-meadows and seepage swamps; rare in fallow fields.

Carex oblita. *C. venusta* var. *minor* of *Gray's Manual.* One station in seepage swamp.

Carex pensylvanica. One station in sandy wood margin.

Carex richii. *C. hormathodes* var. *richii* of *Gray's Manual.* One station in open shrub swamp.

Carex riparia var. *lacustris.* *C. riparia* of *Gray's Manual.* One station along margin of shrub swamp.

Carex rosea. *C. rosea*, in part of *Gray's Manual*, which figures *C. convoluta* as *C. rosea*—see *North American Flora* **18**:45. 1931. Occasional in seepage swamps.

Carex scoparia. Common in wet meadows; occasional in open shrub swamps and sweetgum fields.

Carex seorsa. Rare in seepage swamps.

Carex squarrosa. Occasional in transition swamps and river swamps; rare in seepage swamps.

Carex stipata. Includes var. *maxima*—see *North American Flora* **18**:79. 1931. Occasional in transition swamps and river swamps; rare in seepage swamps.

Carex stricta (Tussock Sedge). *C. stricta*, in part, of *Gray's Manual*—see *North American Flora* **18**:405. 1935. Abundant in shrub swamps and transition swamps; locally common in openings in seepage swamps, and persisting in flooded seepage swamps along lake shores.

Carex swanii. *C. virescens* var. *swanii* of *Gray's Manual.* Abundant in open terrace forest; occasional in open upland oak forest; rare in immature seepage swamps and hedgerows.

Carex tonsa. *C. umbellata* var. *tonsa* of *Gray's Manual.* Occasional in sandy wood margins on upland.

Carex tribuloides. Occasional in wood margins on flood plain; rare in hedgerows and wood margins on upland.

Carex typhina. *C. typhinoides* of *Gray's Manual.* Occasional in transition swamps and river swamps; rare in sweetgum fields and seepage swamps.

Carex umbellata. *C. umbellata* var. *brevirostris* of *Gray's Manual.* One station in open terrace forest.

Carex virescens. One station in margin of terrace forest.

Carex vulpinoidea. Occasional in abandoned fields and wood margins.

Carex willdenowii. Rare in terrace forest and wood margins.

ARACEAE

Arisaema triphyllum (Jack-in-the-pulpit). Common in bottomland forest; occasional in shrub swamps, transition swamps, and river swamps; rare in seepage swamps.

Symplocarpus foetidus (Skunk-cabbage). Common (locally abundant) in shrub swamps and transition swamps; occasional in seepage swamps.

Orontium aquaticum (Golden-club). Occasional in transition swamps and in pools in runs elsewhere on flood plain.

Acorus calamus (Sweet-flag). Established in marsh-meadow from transplantation from tidal Potomac River.

XYRIDACEAE

Xyris caroliniana. Rare along shores of Cash Lake and gravel pit ponds.

Xyris torta. *X. flexuosa* of *Gray's Manual*. Rare in wet meadows and immature seepage swamps.

COMMELINACEAE

Commelina communis (Common Dayflower). Rare in hedgerows, wood margins, and cultivated fields.

Commelina virginica (Hairy Dayflower). *C. hirtella* of *Gray's Manual*. Rare in river swamps.

PONTEDERIACEAE

Pontederia cordata (Pickerel-weed). Rare in transition swamps. Established in Cash Lake from seed and in experimental plant pond from transplantation from tidal Potomac River.

Heteranthera reniformis (Mud-plantain). Two stations: gravel pit pond and experimental plant pond.

JUNCACEAE

Juncus acuminatus. Common in experimental plant ponds; occasional elsewhere in marsh-meadows and wet meadows.

Juncus bufonius. Rare along roads.

Juncus canadensis. Occasional along shore of Cash Lake and elsewhere in marsh-meadows and wet meadows.

Juncus effusus (Soft Rush). Abundant in south end of Lake Redington; common (locally abundant) along shore of Cash Lake; common elsewhere in marsh-meadows, wet meadows, and sweetgum fields; rare in damp fallow fields.

Juncus marginatus. Occasional in wet meadows.

Juncus scirpoides. Occasional along shore of Cash Lake and elsewhere in wet meadows; rare in sweetgum fields.

Juncus secundus. Occasional in wet meadows.

Juncus tenuis. Includes *J. dichotomus* of *Gray's Manual*. Occasional (locally common) in fallow fields; occasional in wet meadows, sweetgum fields, and pastures.

Luzula bulbosa. *L. campestris* var. *bulbosa* of *Gray's Manual*. Rare in sandy wood margins.

Luzula echinata. Not treated in *Gray's Manual*—see *Rhodora* **40**:84. 1938. Occasional (locally common) in terrace forest and bluff forest; rare in seepage swamps.

LILIACEAE

Stenanthium robustum. Rare in transition swamps.

Uvularia perfoliata (Bellwort). Two stations: bottomland forest and bluff forest.

Uvularia sessilifolia (Little Bellwort). *Oakesia sessilifolia* of *Gray's Manual*. Common in bottomland forest; rare in seepage swamps and terrace forest.

Allium canadense (Canada Onion). Rare in bottomland forest.

Allium vineale (Wild Onion). Occasional (locally common) in bottomland forest, fallow fields, and lawns; occasional in sweetgum fields, pastures, and hedgerows; rare in immature seepage swamps, abandoned fields, pine fields, and cultivated fields.

Hemerocallis fulva (Daylily). One station in wood margin on flood plain.

Lilium superbum (Turks-cap Lily). Rare in shrub swamps, transition swamps, river swamps, seepage swamps, sweetgum fields, and immature seepage swamps.

Erythronium americanum (Yellow Adders-tongue). Abundant in bottomland forest; rare in terrace and bluff forest.

Ornithogalum umbellatum (Star-of-Bethlehem). Common (locally abundant) in fallow fields on terrace; rare in lawns.

Asparagus officinalis (Asparagus). Rare in hedgerows.

Smilacina racemosa (False Solomons-seal). Occasional in bottomland forest, pine-beech forest, and terrace forest; rare in bluff forest.

Maianthemum canadense (False Lily-of-the-valley). Occasional (locally common) in shrub swamps, transition swamps, and seepage swamps.

Polygonatum biflorum (Smooth Solomons-seal). Not *P. biflorum* of *Gray's Manual*—see *Rhodora* **46**:11. 1944. Rare in bluff forest; one station in seepage swamp.

Polygonatum canaliculatum (Big Solomons-seal). *P. commutatum* of *Gray's Manual*. Rare in bottomland forest.

Medeola virginiana (Indian Cucumber-root). Common in terrace forest; occasional in seepage swamps and bluff forest.

Aletris farinosa (Star-grass). Occasional (locally common) in pine fields; rare in immature seepage swamps and pine stands.

Smilax glauca (White-leaf Greenbrier). Common (locally abundant) in sweetgum fields, immature seepage swamps, pine stands, hedgerows, and wood margins; common in seepage swamps, abandoned fields, pine fields, terrace forest, and bluff forest; occasional in pine-oak forest and upland oak forest; rare in cultivated fields.

Smilax herbacea (Carrion-flower). Rare in seepage swamps, terrace forest, hedgerows, and wood margins; one station in bottomland forest.

Smilax rotundifolia (Roundleaf Greenbrier). Abundant in hedgerows and wood margins; common in seepage swamps; occasional in shrub swamps, bottomland forest, immature seepage swamps, terrace forest, and bluff forest.

DIOSCOREACEAE

Dioscorea quaternata (Wild Yam-root). Not treated in *Gray's Manual*—see *Rhodora* **39**:399. 1937. Occasional in terrace forest and bluff forest; rare in open river swamps, seepage swamps, and wood margins.

AMARYLLIDACEAE

Narcissus pseudo-narcissus (Daffodil). Two stations: fallow field and Ailanthus thicket.

Hypoxis hirsuta (Yellow Star-grass). Rare in wood margins.

IRIDACEAE

Iris pseudacorus (Yellow Iris). Established in experimental plant pond and marsh-meadow from transplantations from tidal Potomac River.

Iris versicolor (Blue Iris). *I. versicolor*, in part, of *Gray's Manual*—see *Annals of the Missouri Botanical Garden* **15**:254. 1928. Rare in marsh-meadows.

Sisyrinchium atlanticum. Rare in wet meadows.

Sisyrinchium graminoides. *S. gramineum* of *Gray's Manual*. Occasional in wet meadows and lawns.

ORCHIDACEAE

Cypripedium acaule (Pink Lady-slipper). Occasional (locally common) in pine stands and pine-oak forest; occasional in seepage swamps; rare in terrace forest and upland oak forest.

Orchis spectabilis (Showy Orchid). One station in bottomland forest.

Habenaria ciliaris (Orange Fringe-orchid). Common at two stations: seepage swamp and immature seepage swamp.

Habenaria clavellata (Green Wood-orchid). One station in seepage swamp.

Habenaria flava (Tubercled Orchid). Occasional in river swamps.

Habenaria lacera (Green Fringe-orchid). Rare in river swamps.

Isotria verticillata (Whorled Pogonia). *Pogonia verticillata* of *Gray's Manual*. Occasional in terrace forest and bluff forest; rare in pine-oak forest and upland oak forest.

Spiranthes cernua (Nodding Ladies-tresses). Rare in wet meadows.

Spiranthes gracilis (Slender Ladies-tresses). Occasional (locally common) in pine fields.

Spiranthes vernalis (Upland Ladies-tresses). Rare in abandoned fields.

Goodyera pubescens (Rattlesnake-plantain). *Epipactis pubescens* of *Gray's Manual*. Occasional in seepage swamps, pine-beech forest, terrace forest, bluff forest, and pine-oak forest; rare in immature seepage swamps.

Corallorrhiza odontorhiza (Late Coralroot). Two stations: seepage swamp and terrace forest.

Tipularia discolor (Cranefly Orchid). Occasional in seepage swamps, pine-beech forest, terrace forest, and bluff forest.

SALICACEAE

Salix humilis (Prairie Willow). Includes *S. tristis* of *Gray's Manual*. Occasional in immature seepage swamps and damp hedgerows and wood margins; rare in abandoned fields.

Salix nigra (Black Willow). Occasional (locally common) in river swamps; occasional in shrub swamps, transition swamps, immature seepage swamps, and damp hedgerows.

Populus alba (White Poplar). Rare in wood margins.

Populus grandidentata (Bigtooth Aspen). Occasional in immature seepage swamps, seepage swamps, and upland oak forest.

MYRICACEAE

Myrica pensylvanica (Bayberry). *M. carolinensis* of *Gray's Manual.* Rare in sweetgum fields and immature seepage swamps.

JUGLANDACEAE

Juglans cinerea (Butternut). Rare in bottomland forest.

Carya cordiformis (Bitternut). Occasional in bottomland forest and wood margins; rare in immature seepage swamps, terrace forest, bluff forest, and hedgerows; one station in upland oak forest.

Carya glabra (Pignut). Occasional (locally common) in terrace forest; occasional in bluff forest and upland oak forest; rare in bottomland forest and hedgerows.

Carya ovalis (Red Hickory). *C. microcarpa* of *Gray's Manual.* One tree in upland oak forest.

Carya tomentosa (Mockernut). *C. alba* of *Gray's Manual.* Occasional in terrace forest, bluff forest, and upland oak forest; rare in hedgerows.

BETULACEAE

Corylus americana (Hazelnut). Occasional (locally common) in partially cut over bottomland forest, hedgerows, and wood margins; rare in terrace forest.

Carpinus caroliniana (Hornbeam). Abundant in bottomland forest; occasional in river swamps, seepage swamps on terrace, cut-over terrace forest and bluff forest, and wood margins on flood plain and terrace; rare in hedgerows on terrace.

Betula nigra (River Birch). Common (locally abundant) in river swamps and bottomland forest; common in wood margins on flood plain and terrace; occasional in shrub swamps, transition swamps, and seepage swamps; rare in sweetgum fields, immature seepage swamps, and hedgerows.

Alnus serrulata (Alder). *A. rugosa* of *Gray's Manual.* Abundant in shrub swamps; occasional in transition swamps, immature seepage swamps, and damp hedgerows and wood margins.

FAGACEAE

Fagus grandifolia (Beech). Abundant in bottomland forest, pine-beech forest, terrace forest, and bluff forest; occasional in seepage swamps and upland oak forest; rare in immature seepage swamps and hedgerows.

Castanea dentata (Chestnut). Occasional as sprouts in upland oak forest.

Castanea pumila (Chinquapin). Occasional (locally common) in cut-over upland oak forest; rare in pine-oak forest.

Quercus alba (White Oak). Abundant in terrace forest, bluff forest, and upland oak forest; occasional in seepage swamps and pine-oak forest; rare in bottomland forest and hedgerows.

Quercus bicolor (Swamp White Oak). Occasional in transition swamps and river swamps; rare in seepage swamps.

Quercus borealis (Northern Red Oak). *Q. rubra* of *Gray's Manual.* Occasional in bottomland forest, terrace forest, and bluff forest; rare in upland oak forest and hedgerows.

Quercus coccinea (Scarlet Oak). Abundant in upland oak forest; occasional in pine-oak forest; rare in terrace forest and bluff forest.

Quercus falcata (Southern Red Oak). Abundant in pine-oak forest; occasional in pine stands, terrace forest, bluff forest, and upland oak forest; rare in immature seepage swamps and hedgerows.

Quercus ilicifolia (Bear Oak). Rare in partially cut-over upland oak forest.

Quercus imbricaria (Shingle Oak). Rare in pine-oak forest, upland oak forest, hedgerows, and wood margins.

Quercus lyrata (Overcup Oak). Occasional (locally common) in river swamps; rare in shrub swamps and transition swamps.

Quercus marilandica (Blackjack Oak). Occasional in upland oak forest and pine-oak forest.

Quercus montana (Chestnut Oak). *Q. prinus* of *Gray's Manual.* Occasional in upland oak forest and pine-oak forest.

Quercus palustris (Pin Oak). Abundant in river swamps; common in transition swamps, bottomland forest, and damp hedgerows; occasional in shrub swamps, sweetgum fields, immature seepage swamps, and seepage swamps; rare in pine fields.

Quercus phellos (Willow Oak). Common in seepage swamps and damp hedgerows; occasional in river swamps and immature seepage swamps; rare in bottomland forest, sweetgum fields, pine fields, pine stands, terrace forest, and pine-oak forest.

Quercus prinus (Swamp Chestnut Oak). *Q. michauxii* of *Gray's Manual.* Occasional (locally common) in bottomland forest; rare in river swamps.

Quercus stellata (Post Oak). Occasional in pine-oak forest; rare in terrace forest and upland oak forest.

Quercus velutina (Black Oak). Common in upland oak forest; occasional in terrace forest; rare in bluff forest and pine-oak forest.

URTICACEAE

Ulmus americana (American Elm). Common in bottomland forest; occasional in river swamps; rare in sweetgum fields and hedgerows on terrace.

Humulus lupulus (Hop). Two stations: bottomland forest and seepage swamp.

Broussonetia papyrifera (Paper-mulberry). One station in abandoned yard—spreading from cultivated plant.

Morus alba (White Mulberry). One station in hedgerow.

Morus rubra (Red Mulberry). Rare in bottomland forest and hedgerows; one station in seepage swamp.

Urtica dioica (Stinging Nettle). One station in Ailanthus thicket.

Laportea canadensis (Wood-nettle). Abundant in bottomland forest.

Pilea pumila (Richweed). Occasional (locally common) in river swamps and shallow runs in bottomland forest; rare in terrace forest.

Boehmeria cylindrica (False-nettle). Common in river swamps; rare in bottomland forest, terrace forest, and damp hedgerows.

SANTALACEAE

Comandra umbellata (Bastard Toadflax). Rare in wood margins on terrace.

LORANTHACEAE

Phoradendron flavescens (Mistletoe). Occasional on Blackgum in bottomland forest and seepage swamps.

ARISTOLOCHIACEAE

Asarum canadense (Wild-ginger). Occasional in bottomland forest.

POLYGONACEAE

Rumex acetosella (Sheep-sorrel). Abundant in fallow fields; common in sweetgum fields and lawns; occasional (locally common) in abandoned fields, pine fields, cultivated fields, and pastures.

Rumex crispus (Yellow Dock). Occasional in fallow fields and pastures.

Rumex obtusifolius (Bitter Dock). Occasional (locally common) in fallow fields and pastures.

Polygonum arifolium (Halberd-leaf Tear-thumb). Common in transition swamps and river swamps; occasional in shrub swamps.

Polygonum aviculare (Knotweed). One station in fallow field.

Polygonum dumetorum. One station in wood margin.

Polygonum erectum (Upright Knotweed). One station in fallow field.

Polygonum hydropiper (Common Smartweed). Rare in wet meadows.

Polygonum hydropiperoides (Swamp Smartweed). Occasional (locally common) in pools in runs on flood plain; occasional in south end of Lake Redington. Established in Cash Lake from transplantation from Swanson Creek, Charles County.

Polygonum pensylvanicum (Pennsylvania Smartweed). Abundant in fallow fields and damp cultivated fields; common in 1946 along shore of Lake Redington, where it was seeded and was abundant in 1945; occasional in wet meadows.

Polygonum persicaria (Lady's-thumb). Common in 1946 along shore of Lake Redington, where it was seeded and was abundant in 1945; occasional (locally abundant) in fallow fields and cultivated fields; rare in wet meadows.

Polygonum punctatum (Dotted Smartweed). *P. acre* of *Gray's Manual*. Common in south end of Lake Redington in 1946; occasional in transition swamps, river swamps, and wet meadows; rare in damp hedgerows.

Polygonum sagittatum (Arrow-leaf Tear-thumb). Common (locally abundant) in marsh-meadows and open shrub swamps; occasional in damp hedgerows; rare in seepage swamps.

Polygonum scandens. Rare in wood margins.

Polygonum tenue. One station in road.

Tovara virginiana. *Polygonum virginianum* of *Gray's Manual*. Occasional (locally common) in river swamps; rare in bottomland forest.

CHENOPODIACEAE

Chenopodium album (Lambs-quarters). Common in fallow fields and cultivated fields.

Chenopodium ambrosioides (Mexican-tea). Rare in fallow fields; one station each in hedgerow and cultivated field.

AMARANTHACEAE

Amaranthus hybridus (Slim Pigweed). Common in fallow fields and cultivated fields.

Amaranthus retroflexus (Redroot Pigweed). One station in fallow field.

Amaranthus spinosus (Spiny Pigweed). One station in cultivated field.

PHYTOLACCACEAE

Phytolacca americana (Pokeweed). *P. decandra* of *Gray's Manual.* Common in wood margins; rare in fallow fields, hedgerows, and cultivated fields.

ILLECEBRACEAE

Scleranthus annuus (Knawel). Rare in fallow fields.

AIZOACEAE

Mollugo verticillata (Carpetweed). Common (locally abundant) in cultivated fields; occasional in fallow fields.

CARYOPHYLLACEAE

Arenaria serpyllifolia (Thyme-leaf Sandwort). Two stations: fallow field and lawn.

Stellaria longifolia (Longleaf Starwort). Common in bottomland forest.

Stellaria media (Chickweed). Common in fallow fields and cultivated fields; occasional (locally common) in bottomland forest and lawns.

Stellaria pubera. (Starwort). Common in bottomland forest; rare in bluff forest.

Cerastium viscosum. Common in pastures and lawns; occasional in fallow fields.

Cerastium vulgatum. Occasional in pastures and lawns.

Agrostemma githago (Cockle). One station in grainfield.

Lychnis alba (White Campion). Rare in fallow fields.

Silene antirrhina (Sleepy Catchfly). One station along road.

Silene stellata (Starry Campion). Rare in bluff forest.

Dianthus armeria (Deptford Pink). Occasional in fallow fields, abandoned fields, pine fields, and lawns.

PORTULACACEAE

Claytonia virginica (Spring-beauty). Very abundant in bottomland forest; rare in seepage swamps, terrace forest, and bluff forest.

Portulaca oleracea (Purslane). Occasional in cultivated fields; rare in fallow fields.

NYMPHAEACEAE

Nuphar advena (Spatterdock). *Nymphaea advena* of *Gray's Manual.* Common in Cash Lake and pool below Cash Lake dam; occasional near head of Lake Redington and in brooks on flood plain. Accidentally established in experimental plant pond through introduction of muck soil from Cash Branch swamp.

Nymphaea odorata (White Waterlily). *Castalia odorata* of *Gray's Manual.* Occasional (locally abundant) in Cash Lake in 1945, having increased from a very small amount first noted in 1942. Established in experimental plant pond from transplantation from Lakeland, Prince Georges County.

Brasenia schreberi (Water-shield). Established in Cash Lake, gravel pit pond, and experimental plant pond from transplantations from Edmonston, Prince Georges County.

RANUNCULACEAE

Ranunculus abortivus (Small-flowered Buttercup). Common in bottomland forest; rare in seepage swamps.

Ranunculus acris (Tall Buttercup). One station in wet meadow.

Ranunculus ambigens (Tall Spearwort). *R. laxicaulis* of *Gray's Manual.* Occasional in pools in runs on flood plain and in marsh-meadows.

Ranunculus bulbosus (Bulbous Buttercup). Occasional in lawns.

Ranunculus hispidus (Hairy Buttercup). Occasionally (locally common) in river swamps; rare in bottomland forest.

Ranunculus pusillus (Low Spearwort). Rare in marsh-meadows.

Ranunculus recurvatus (Hooked Buttercup). Occasional (locally common) in bottomland forest.

Ranunculus repens (Creeping Buttercup). Rare in wet meadows.

Thalictrum polygamum (Tall Meadow-rue). Occasional in wet meadows and wood margins on flood plain.

Anemonella thalictroides (Rue-anemone). Occasional in bottomland forest; rare in terrace forest and bluff forest.

Anemone quinquefolia (Wood Anemone). Rare in bottomland forest and seepage swamps.

Clematis virginiana (Virgins-bower). Rare in wood margins on flood plain; one station in seepage swamp.

MAGNOLIACEAE

Magnolia virginiana (Sweetbay). Common in shrub swamps, transition swamps, and seepage swamps.

Liriodendron tulipifera (Tulip-tree). Common (locally abundant) in bottomland forest; occasional (locally common) in seepage swamps; occasional in immature seepage swamps; rare in sweetgum fields, pine fields, terrace forest, bluff forest, and hedgerows.

ANNONACEAE

Asimina triloba (Pawpaw). Occasional in bottomland forest; rare in seepage swamps.

BERBERIDACEAE

Podophyllum peltatum (May-apple). Common (locally abundant) in bottomland forest; rare in seepage swamps; one station in hedgerow.

Berberis thunbergii (Japanese Barberry). Not treated in *Gray's Manual*—see Bailey, *Manual of cultivated plants*, p. 288. 1924. Two stations: bottomland forest and sweetgum field.

LAURACEAE

Sassafras albidum (Sassafras). *S. variifolium* of *Gray's Manual.* Common in hedgerows and wood margins; rare in bottomland forest, pine fields, terrace forest, bluff forest, pine-oak forest, and upland oak forest.

Lindera benzoin (Spicebush). *Benzoin aestivale* of *Gray's Manual.* Common in transition swamps and bottomland forest; occasional in shrub swamps; rare in immature seepage swamps, seepage swamps, terrace forest, and damp hedgerows.

PAPAVERACEAE

Sanguinaria canadensis (Bloodroot). Rare in bottomland forest; one station in bluff forest.

Chelidonium majus (Celandine). One station in abandoned yard.

FUMARIACEAE

Dicentra cucullaria (Dutchmans-breeches). Occasional in bottomland forest.

Corydalis flavula (Yellow Corydalis). Occasional in bottomland forest.

CRUCIFERAE

Draba verna (Whitlow-grass). Common (locally abundant) in fallow fields and lawns.

Thlaspi arvense (Pennycress). One station in fallow field.

Lepidium campestre (English Peppergrass). Occasional in fallow fields.

Lepidium virginicum (Wild Peppergrass). Rare in fallow fields.

Capsella bursa-pastoris (Shepherds-purse). Occasional in fallow fields.

Raphanus sativus (Radish). Rare in fallow fields.

Sisymbrium altissimum (Tumble-mustard). One station in fallow field.

Sisymbrium officinale (Hedge-mustard). Rare in fallow fields.

Sisymbrium thalianum (Mouse-ear Cress). Occasional (locally common) in fallow fields and cultivated fields; rare in lawns.

Rorippa islandica (Marsh-cress). *Radicula palustris* of *Gray's Manual*. Rare in margins of swamps on flood plain.

Barbarea verna (Early Wintercress). Common (locally abundant) in fallow fields.

Barbarea vulgaris (Common Wintercress). Occasional in fallow fields.

Dentaria laciniata (Pepper-root). Common in bottomland forest.

Cardamine bulbosa (Bulbous Bitter-cress). Occasional in river swamps; rare in bottomland forest.

Cardamine pensylvanica (Pennsylvania Bitter-cress). Occasional in river swamps; rare in bottomland forest.

PODOSTEMACEAE

Podostemum ceratophyllum (Riverweed). Locally common in river in swift, shallow water on coarse gravel bottom.

CRASSULACEAE

Penthorum sedoides (Ditch-stonecrop). Rare in margins of swamps on flood plain.

SAXIFRAGACEAE

Heuchera americana (Alumroot). Rare in bottomland forest and bluff forest.

Hydrangea arborescens (Wild Hydrangea). One station in bluff forest.

Itea virginica (Itea). Rare in transition swamps; one station in shrub swamp.

HAMAMELIDACEAE

Hamamelis virginiana (Witch-hazel). Rare in terrace forest; one station in bluff forest.

Liquidambar styraciflua (Sweetgum). Very abundant in sweetgum fields and immature seepage swamps; abundant in river swamps, bottomland forest, and damp hedgerows; common in transition swamps and seepage swamps on terrace; occasional in pine fields, pine-beech forest, terrace forest, and bluff forest.

PLATANACEAE

Platanus occidentalis (Sycamore). Occasional in bottomland forest; rare in sweetgum fields and damp hedgerows.

ROSACEAE

Spiraea latifolia (Meadow-sweet). Rare in margins of shrub swamps; common at one station in sweetgum field.

Spiraea tomentosa (Hardhack). Occasional in sweetgum fields.

Gillenia trofoliata (Bowmans-root). One station in upland oak forest.

Pyrus communis (Pear). Four stations; bottomland forest, sweetgum field, abandoned field, and terrace forest.

Malus angustifolia (Southern Crabapple). *Pyrus angustifolia* of *Gray's Manual*. One station in hedgerow.

Aronia arbutifolia (Red Chokeberry). *Pyrus arbutifolia* of *Gray's Manual*. Occasional (locally common) in shrub swamps; occasional in seepage swamps and damp hedgerows.

Aronia melanocarpa (Black Chokeberry). *Pyrus melanocarpa* of *Gray's Manual*. Rare in seepage swamps.

Aronia prunifolia (Purple Chokeberry). *Pyrus arbutifolia* var. *atropurpurea* of *Gray's Manual*. Rare in shrub swamps.

Amelanchier arborea (Downy Serviceberry). *A. canadensis* var. *botryapium* of *Gray's Manual*. Occasional (locally common) in pine-oak forest and upland oak forest; occasional in terrace forest and bluff forest; rare in seepage swamps.

Amelanchier canadensis (Swamp Serviceberry). *A. oblongifolia* of *Gray's Manual*. Occasional in shrub swamps; rare in sweetgum fields and damp hedgerows.

Crataegus boyntoni (Boynton Hawthorn). Rare in wood margins on upland.

Crataegus rubella (Reddish Hawthorn). Not treated in *Gray's Manual*—see *Brittonia* **5**:484. 1946. Two stations: upland oak forest and wood margin.

Fragaria virginiana (Wild Strawberry). Occasional in abandoned fields and pine fields; rare in sweetgum fields, fallow fields, and hedgerows.

Duchesnea indica (Mock-strawberry). Rare in bottomland forest.

Potentilla canadensis (Dwarf Cinquefoil). *P. pumila* of *Gray's Manual*. Occasional in abandoned fields, pine fields, pastures, and wood margins; rare in sweetgum fields and hedgerows.

Potentilla monspeliensis (Rough Cinquefoil). Occasional in wet meadows and fallow fields; rare in lawns.

Potentilla recta (Sulfur Cinquefoil). Rare in abandoned fields.

Potentilla simplex (Common Cinquefoil). *P. canadensis* of *Gray's Manual*. Common (locally abundant) in sweetgum fields; occasional (locally common) in abandoned fields, pine fields, and hedgerows; occasional in fallow fields; rare in bottomland forest and wood margins.

Geum canadense (White Avens). Common in bottomland forest; rare in hedgerows; one station in Ailanthus thicket.

Geum vernum (Spring Avens). One station in bottomland forest.

Rubus cordialis (Dewberry). Not treated in *Gray's Manual*—see *Gentes Herbarum* **5**:271. 1943. Two stations: hedgerow and wood margin.

Rubus cuneifolius (Sand Blackberry). Rare in sandy abandoned fields.

Rubus flagellaris (Dewberry). Not treated in *Gray's Manual*—see *Gentes Herbarum*

5:244. 1943. Two stations: hedgerow and wood margin.

Rubus frondosus (Highbush Blackberry). *R. frondosus*, in part, of *Gray's Manual*—see *Gentes Herbarum* **5**:732. 1945. One station in hedgerow.

Rubus fusus (Dewberry). Not treated in *Gray's Manual*—see *Gentes Herbarum* **5**:390. 1943. One station in hedgerow.

Rubus hispidus (Swamp Dewberry). Abundant in transition swamps and seepage swamps; common in shrub swamps; occasional in sweetgum fields, immature seepage swamps, and damp hedgerows.

Rubus occidentalis (Black Raspberry). Rare in hedgerows and wood margins.

Rubus pensilvanicus (Highbush Blackberry). Not treated in *Gray's Manual*—see *Gentes Herbarum* **5**:699. 1945. Two stations in hedgerows.

Rubus subtractus (Highbush Blackberry). Not treated in *Gray's Manual*—see *Gentes Herbarum* **5**:632. 1945. One station in hedgerow. Dewberries as a group are common (locally abundant) in sweetgum fields, abandoned fields, pine fields, and fallow fields. Highbush blackberries as a group are abundant in hedgerows and wood margins.

Agrimona parviflora. Rare in wood margins on flood plain.

Agrimonia pubescens. *A. mollis* of *Gray's Manual*. One station in hedgerow.

Sanguisorba canadensis (Burnet). Rare in open shrub swamps.

Rosa carolina (Pasture Rose). *R. humilis* of *Gray's Manual*. Occasional in hedgerows and wood margins.

Rosa palustris (Swamp Rose). *R. carolina* of *Gray's Manual*. Common in shrub swamps.

Prunus americana (American Plum). Two stations: hedgerow and wood margin.

Prunus avium (Sweet Cherry). One tree in pine-oak forest.

Prunus persica (Peach). One station in hedgerow.

Prunus serotina (Black Cherry). Occasional (locally common) in hedgerows; occasional in wood margins; rare in bottomland forest, sweetgum fields, immature seepage swamps, pine fields, bluff forest, and pine-oak forest.

LEGUMINOSAE

Cassia fasciculata (Big Partridge-pea). *C. chamaecrista* of *Gray's Manual*. Common in fallow fields; occasional in lawns.

Cassia hebecarpa (Wild Senna). *C. marilandica* of *Gray's Manual*. Rare in hedgerows and wood margins.

Cassia nictitans (Little Partridge-pea). Common in fallow fields; occasional in abandoned fields, pine fields, and lawns; rare in sweetgum fields.

Baptisia tinctoria (Wild-indigo). Occasional in open terrace forest, open upland forest, and wood margins.

Crotalaria sagittalis (Rattlebox). Occasional in fallow fields; rare in abandoned fields and pine fields.

Trifolium agrarium (Hop Clover). Occasional (locally common) in fallow fields; rare in abandoned fields and pine fields.

Trifolium arvense (Rabbitfoot Clover). Common in fallow fields; rare in sweetgum fields, abandoned fields, and lawns.

Trifolium dubium (Little Hop Clover). Common in headquarters lawn; occasional in fallow fields.

Trifolium hybridum (Alsike). Occasional (locally common) in fallow fields; occasional in lawns.

Trifolium pratense (Red Clover). Occasional (locally common) in fallow fields; occasional in lawns.

Trifolium procumbens (Low Hop Clover). Common in headquarters lawn; occasional (locally common) in fallow fields.

Trifolium repens (White Clover). Abundant in lawns and common in pastures (presumably persisting from seeding in each); occasional in fallow fields.

Melilotus alba (White Sweetclover). Rare in fallow fields.

Melilotus officinalis (Yellow Sweetclover). Rare in fallow fields.

Medicago lupulina (Black Medic). Occasional in fallow fields and lawns.

Medicago sativa (Alfalfa). Two stations: lawn and roadside.

Tephrosia virginiana. Occasional in pine-oak forest and upland oak forest.

Robinia pseudoacacia (Black Locust). Occasional (locally abundant) in pine fields; occasional in hedgerows; rare in pine stands, terrace forest, and upland oak forest.

Desmodium bracteosum. One station in hedgerow.

Desmodium ciliare. *D. obtusum* of *Gray's Manual*. Occasional in abandoned fields; rare in pine fields.

Desmodium dillenii. Occasional (locally common) in abandoned fields and wood margins; rare in sweetgum fields, pine fields, and hedgerows.

Desmodium laevigatum. Occasional in abandoned fields and wood margins.

Desmodium marilandicum. Occasional in abandoned fields; rare in pine fields.

Desmodium nudiflorum. Occasional in terrace forest, bluff forest, and upland oak forest; rare in pine-oak forest.

Desmodium paniculatum. Occasional (locally common) in abandoned fields and wood margins; rare in sweetgum fields and pine fields.

Desmodium rigidum. Rare in abandoned fields on terrace.

Desmodium rotundifolium. One station in bluff forest.

Desmodium viridiflorum. Occasional in abandoned fields.

Lespedeza capitata (Roundhead Lespedeza). Occasional in abandoned fields.

Lespedeza cuneata (Sericea Lespedeza). Not treated in *Gray's Manual*—see Graham, *Legumes for erosion control and wildlife*, p. 64. 1941. Common (locally abundant) along roads; occasional (locally common) in abandoned fields. Seeded in several abandoned fields.

Lespedeza hirta (Hairy Lespedeza). Rare in abandoned fields on terrace.

Lespedeza intermedia (Wand Lespedeza). *L. frutescens* of *Gray's Manual*. Rare in abandoned fields on terrace.

Lespedeza nuttallii (Nuttall Lespedeza). One station in wood margin.

Lespedeza procumbens (Trailing Lespedeza). Rare in sweetgum fields, immature seepage swamps, and pine-oak forest.

Lespedeza repens (Creeping Lespedeza). Occasional in abandoned fields; rare in pine fields, pine-oak forest, and wood margins.

Lespedeza stipulacea (Korean Lespedeza). Not treated in *Gray's Manual*—see Graham, *Legumes for erosion control and wildlife*, p. 65, 1941. Abundant in headquarters lawn (presumably persisting from seeding); occasional along roads.

Lespedeza striata (Common Lespedeza). Occasional (locally common) in fallow fields and lawns.

Lespedeza stuvei (Stuve Lespedeza). Rare in abandoned fields.

Lespedeza virginica (Slender Lespedeza). Common in abandoned fields and pine fields.

Stylosanthes biflora (Pencil-flower). Rare in open terrace forest.

Vicia angustifolia (Narrowleaf Vetch). One station in abandoned field.

Vicia tetrasperma (Sparrow Vetch). One station in abandoned field.

Vicia villosa (Hairy Vetch). Rare in fallow fields.

Apios americana (Potato-bean). *A. tuberosa* of *Gray's Manual*. Occasional in sweetgum fields and damp hedgerows.

Strophostyles umbellata (Wild-bean). Rare in abandoned fields.

Amphicarpa bracteata (Hog-peanut). *A. monoica* of *Gray's Manual*. Occasional (locally common) in bottomland forest; rare in seepage swamps and terrace forest; one station in hedgerow.

LINACEAE

Linum floridanum. Rare in wet meadows, sweetgum fields, and pine fields.

Linum striatum. Occasional in wet meadows.

Linum virginianum. Rare in wood margins on upland.

OXALIDACEAE

Oxalis europaea (European Yellow Oxalis). *O. corniculata* of *Gray's Manual*. One station in wood margin on flood plain.

Oxalis stricta (Common Yellow Oxalis). Occasional in fallow fields, abandoned fields, pine fields, and lawns; rare in open terrace forest.

Oxalis violacea (Violet Oxalis). Rare in bottomland forest.

GERANIACEAE

Geranium carolinianum (Carolina Geranium). Occasional in fallow fields and wood margins; rare in lawns.

Geranium maculatum (Wild Geranium). Occasional in bottomland forest; one station in bluff forest.

Geranium pusillum (Small Geranium). One station in fallow field.

Erodium cicutarium (Filaree). Rare in fallow fields.

SIMARUBACEAE

Ailanthus altissima (Ailanthus). *A. glandulosa* of *Gray's Manual*. One thicket in abandoned yard.

POLYGALACEAE

Polygala curtissii. Occasional (locally common) in abandoned fields and pine fields; rare in sweetgum fields and fallow fields.

Polygala mariana. Rare in wet meadows; one station in damp pasture.

Polygala sanguinea. Occasional in wet meadows; rare in fallow fields.

Polygala verticillata. Occasional in fallow fields and abandoned fields.

EUPHORBIACEAE

Acalypha gracilens. A. gracilens, in part, of *Gray's Manual*—see *Rhodora* **29**:201. 1927. Rare in fallow fields, abandoned fields, pine fields, cultivated fields, and wood margins.

Acalypha rhomboidea. A. virginica of *Gray's Manual.* Occasional in fallow fields, cultivated fields, and wood margins; rare in hedgerows.

Euphorbia corollata (Flowering Spurge). Common in fallow fields and abandoned fields; occasional in cultivated fields; rare in sweetgum fields and pine fields.

Euphorbia ipecacuanhae (Ipecac Spurge). Rare in opening in forest on upland.

Euphorbia maculata. E. preslii of *Gray's Manual.* Occasional in fallow fields and cultivated fields.

Euphorbia supina. E. maculata of *Gray's Manual.* Rare in fallow fields and cultivated fields.

CALLITRICHACEAE

Callitriche austini. C. deflexa var. *austini* of *Gray's Manual.* Rare in damp wood margins.

Callitriche heterophylla (Water-starwort). Common (locally abundant) in gravel pit ponds and experimental plant ponds; occasional (locally common) in pools in runs and in brooks on flood plain.

ANACARDIACEAE

Rhus copallina (Shining Sumac). Common (locally abundant) in pine fields, hedgerows, and wood margins; occasional in sweetgum fields and immature seepage swamps.

Rhus glabra (Smooth Sumac). Occasional in hedgerows and wood margins; rare in pine fields.

Rhus typhina (Staghorn Sumac). Rare in hedgerows.

Toxicodendron radicans (Poison-ivy). *Rhus toxicodendron* of *Gray's Manual.* Abundant in river swamps and bottomland forest; common in hedgerows and wood margins; occasional in transition swamps, seepage swamps, sweetgum fields, pine fields, terrace forest, and bluff forest; rare in immature seepage swamps, pine stands, and pine-oak forest.

Toxicodendron vernix (Poison-sumac). *Rhus vernix* of *Gray's Manual.* Common in shrub swamps; occasional in transition swamps; rare in seepage swamps.

AQUIFOLIACEAE

Ilex laevigata (Smooth Winterberry). Rare in seepage swamps.

Ilex opaca (Holly). Common in seepage swamps; occasional (locally common) in pine-beech forest and terrace forest; occasional in pine stands; rare in bottomland forest, immature seepage swamps, pine-oak forest, and hedgerows.

Ilex verticillata (Winterberry). Common (locally abundant) in transition swamps; common in shrub swamps; occasional in seepage swamps; rare in damp hedgerows.

CELASTRACEAE

Evonymus americanus (Strawberry-bush). Occasional (locally common) in pine-beech forest and terrace forest; occasional in bottomland forest and seepage swamps; rare in immature seepage swamps, bluff forest, and hedgerows.

STAPHYLEACEAE

Staphylea trifolia (Bladdernut). Rare in bottomland forest.

ACERACEAE

Acer negundo (Box-elder). Rare in bottomland forest.

Acer rubrum (Red Maple). Abundant in transition swamps and river swamps; common in shrub swamps, bottomland forest, and seepage swamps; occasional in sweetgum fields, immature seepage swamps, pine fields, pine stands, pine-beech forest, terrace forest, bluff forest, and hedgerows.

Acer saccharinum (Silver Maple). Occasional near river in bottomland forest.

BALSAMINACEAE

Impatiens biflora (Touch-me-not). Abundant in bottomland forest; locally common in seepage swamps on upland; occasional in river swamps; rare in damp hedgerows; one station in Ailanthus thicket.

RHAMNACEAE

Ceanothus americanus (New Jersey Tea). Rare in dry wood margins on upland.

VITACEAE

Parthenocissus quinquefolia (Virginia Creeper). *Psedera quinquefolia* of *Gray's Manual*. Common in bottomland forest; occasional in terrace forest, bluff forest, and hedgerows; rare in shrub swamps, seepage swamps, and pine-oak forest.

Vitis aestivalis (Summer Grape). Common in bottomland forest and wood margins; occasional in hedgerows; rare in pine fields.

Vitis labrusca (Fox Grape). Occasional in bottomland forest, hedgerows, and wood margins; rare in sweetgum fields.

Vitis vulpina (Frost Grape). *V. cordifolia* of *Gray's Manual*. Occasional in bottomland forest, hedgerows, and wood margins.

MALVACEAE

Abutilon theophrasti (Velvet-leaf). Occasional in fallow fields; rare in cultivated fields.

Sida spinosa (Prickly Sida). Two stations: fallow field and lawn.

Malva neglecta (Cheeses). *M. rotundifolia* of *Gray's Manual*. One station in fallow field.

Hibiscus moscheutos (Rose-mallow). *H. oculiroseus* of *Gray's Manual*. Established in marsh-meadow from transplantation from tidal Potomac River.

Hibiscus trionum (Flower-of-an-hour). Rare in fallow fields.

HYPERICACEAE

Ascyrum hypericoides (St. Andrew's Cross). Occasional in abandoned fields, pine fields, and wood margins; rare in open terrace forest and hedgerows.

Hypericum canadense. Occasional in wet meadows; rare in damp fallow fields.

Hypericum denticulatum. *H. virgatum* of *Gray's Manual*. Rare in sweetgum fields.

Hypericum gentianoides (Pineweed). Occasional (locally common) in fallow fields and pine fields; occasional in abandoned fields and wood margins.

Hypericum mutilum. Occasional (locally abundant) in wet meadows and fallow fields.

Hypericum perforatum (Common St. Johnswort). Rare in fallow fields and abandoned fields.

Hypericum punctatum. Occasional in river swamps and damp wood margins on flood plain and terrace; rare in sweetgum fields and damp hedgerows.

Hypericum tubulosum. *H. petiolatum* of *Gray's Manual*. Rare in river swamps.

Hypericum virginicum (Marsh St. Johnswort). Common along shore of Cash Lake; occasional elsewhere in marsh-meadows and open shrub swamps.

CISTACEAE

Helianthemum bicknellii. *H. majus* of *Gray's Manual*. Rare in abandoned fields.

Helianthemum canadense. Occasional in pine fields and dry wood margins.

Lechea leggettii. Two stations: pine field and wood margin.

Lechea racemulosa. Occasional (locally common) in abandoned fields and pine fields.

VIOLACEAE

Viola affinis (Woodland Blue Violet). Common in bottomland forest.

Viola brittoniana (Coast Violet). One station in immature seepage swamp.

Viola cucullata (Marsh Blue Violet). Occasional in shrub swamps and transition swamps; rare in seepage swamps.

Viola fimbriatula (Sand Violet). One station in open pine stand.

Viola lanceolata (Lance-leaf Violet). Occasionally (locally common) in marsh-meadows, wet meadows, and sweetgum fields; rare in damp fallow fields.

Viola papilionacea (Butterfly Violet). Occasional in bottomland forest.

Viola pedata (Birdfoot Violet). Rare in sandy margins of pine-oak forest.

Viola pensylvanica (Yellow Violet). *V. scabriuscula* of *Gray's Manual*. Occasional (locally common) in bottomland forest.

Viola primulifolia (Primrose-leaf Violet). Common in wet meadows; occasional in sweetgum fields; rare in damp fallow fields, hedgerows, and wood margins.

Viola sagittata (Arrow-leaf Violet). Common (locally abundant) in wet meadows; common in sweetgum fields; occasional in fallow fields, abandoned fields, and pine fields.

LYTHRACEAE

Rotala ramosior. Rare in marsh-meadows.

Cuphea petiolata. Occasional in fallow fields.

MELASTOMACEAE

Rhexia mariana (Maryland Meadow-beauty). Common in wet meadows.

Rhexia virginica (Virginia Meadow-beauty). Occasional in wet meadows.

ONAGRACEAE

Ludvigia alternifolia (Seedbox). Occasional (locally common) in wet meadows; rare in sweetgum fields and damp fallow fields.

Ludvigia palustris (Water-purslane). Common in south end of Lake Redington, pools in runs on flood plain, and marsh-meadows.

Epilobium coloratum (Willow-herb). Rare in wet meadows.

Oenothera biennis (Common Evening-primrose). Common in fallow fields; occasional in cultivated fields.

Oenothera fruticosa (Sundrops). *O. linearis* and *O. longipedicellata* of *Gray's Manual*. Occasional (locally common) in wet meadows and sweetgum fields; occasional in abandoned fields and pine fields.

Oenothera laciniata (Cutleaf Evening-primrose). Two stations: pine field and lawn.

Oenothera perennis (Little Sundrops). *O. pumila* of *Gray's Manual*. One station in abandoned field.

Circaea quadrisulcata var. *canadensis* (Enchanters-nightshade). *C. lutetiana* of *Gray's Manual*. Occasional (locally common) in bottomland forest; rare in seepage swamps.

HALORAGIDACEAE

Proserpinaca palustris (Mermaid-weed). Occasional in pools in runs on flood plain and marsh-meadows.

ARALIACEAE

Aralia nudicaulis (Wild-sarsaparilla). Rare in seepage swamps and bluff forest.

Aralia spinosa (Devils-walkingstick). Rare in terrace forest; one station in seepage swamp.

Panax trifolium (Dwarf Ginseng). Common in bottomland forest; rare in seepage swamps, terrace forest, and bluff forest.

UMBELLIFERAE

Sanicula canadensis (Snakeroot). Rare in bottomland forest and seepage swamps on upland.

Hydrocotyle americana (Pennywort). Rare in bottomland forest and terrace forest.

Cicuta maculata (Water-hemlock). Occasional in marsh-meadows and open shrub swamps and river swamps.

Cryptotaenia canadensis (Honewort). Abundant in bottomland forest; rare in seepage swamps on upland.

Thaspium barbinode (Meadow-parsnip). One plant in bottomland forest.

Oxypolis rigidior (Cowbane). Rare in marsh-meadows; one station each in transition swamp and seepage swamp.

Angelica villosa (Hairy Angelica). One station in upland oak forest.

Daucus carota (Wild Carrot). Common (locally abundant) in fallow fields and abandoned fields; occasional in pine fields, cultivated fields, and pastures; rare in sweetgum fields.

CORNACEAE

Cornus amomum (Silky Dogwood). Occasional in margins of shrub swamps, open transition swamps, and damp hedgerows and wood margins.

Cornus florida (Flowering Dogwood). Occasional (locally common) in bottomland forest, terrace forest, bluff forest, and wood margins; rare in seepage swamps, pine fields, pine stands, and hedgerows.

Nyssa sylvatica (Blackgum). Common in seepage swamps; occasional (locally common) in bottomland forest; occasional in transition swamps, river swamps, immature seepage swamps, and hedgerows; rare in sweetgum fields, pine-beech forest, and bluff forest.

ERICACEAE

Clethra alnifolia (Sweet Pepperbush). Abundant in seepage swamps; common in shrub swamps, transition swamps, and damp hedgerows and wood margins; rare in bottomland forest and terrace forest.

Chimaphila maculata (Spotted Wintergreen). Common in pine stands, occasional in terrace forest, bluff forest, and pine-oak forest; rare in upland oak forest.

Chimaphila umbellata (Pipsissewa). Rare in pine stands and pine-oak forest.

Pyrola elliptica (Shin-leaf). One station in damp pine stand.

Pyrola rotundifolia var. *americana* (Roundleaf Wintergreen). *P. americana* of *Gray's* Manual. Occasional in pine-beech forest, pine-oak forest, terrace forest, bluff forest, and upland oak forest.

Pyrola secunda (Sidebells Wintergreen). One station in pine-oak forest.

Pyrola virens (Green-flowered Wintergreen). *P. chlorantha* of *Gray's Manual*. One station in pine-oak forest.

Monotropa hypopitys (Pinesap). Rare in terrace forest, bluff forest, pine-oak forest, and upland oak forest.

Monotropa uniflora (Indian-pipe). Occasional in terrace forest, bluff forest, pine-oak forest, and upland oak forest.

Rhododendron nudiflorum (Pink Azalea). Common in upland oak forest; occasional in terrace forest and bluff forest.

Rhododendron viscosum (Swamp Azalea). Common in shrub swamps and seepage swamps; ocasional in transition swamps; rare in damp hedgerows.

Kalmia angustifolia (Lambkill). Occasional in seepage swamps; rare in shrub swamps.

Kalmia latifolia (Mountain-laurel). Locally abundant in pine-oak forest and upland oak forest; occasional in pine stands and terrace forest; rare in pine-beech forest.

Leucothoe racemosa (Sweetbells). Common in seepage swamps; occasional in shrub swamps and transition swamps; rare in immature seepage swamps.

Lyonia ligustrina (Male-berry). Common (locally abundant) in immature seepage swamps; common in seepage swamps; occasional in shrub swamps, transition swamps, sweetgum fields, and damp hedgerows; rare in terrace forest.

Lyonia mariana (Staggerbush). Occasional in seepage swamps, pine-oak forest, and upland oak forest.

Epigaea repens (Trailing-arbutus). Occasional (locally common) in pine-oak forest and upland oak forest; rare in pine stands and bluff forest.

Gaultheria procumbens (Wintergreen). Large patch in seepage swamp; rare elsewhere in seepage swamps, pine stands, terrace forest, and upland oak forest.

Gaylussacia baccata (Black Huckleberry). Abundant in pine-oak forest and upland oak forest; rare in terrace forest.

Gaylussacia frondosa (Dangleberry). Common (locally abundant) in pine-oak forest and upland oak forest; occasional in seepage swamps, terrace forest, and bluff forest.

Vaccinium angustifolium (Lowbush Blueberry). *V. pennsylvanicum* of *Gray's Manual*. Two stations: pine stand and upland oak forest.

Vaccinium corymbosum (Highbush Blueberry). Includes *V. atrococcum* of *Gray's Manual*. Occasional (locally common) in sweetgum fields, immature seepage swamps, pine fields, and damp hedgerows; occasional in shrub swamps and seepage swamps; rare in transition swamps.

Vaccinium stamineum (Deerberry). Occasional (locally common) in pine-oak forest and upland oak forest; occasional in pine fields, pine stands, and dry wood margins; rare in terrace forest and bluff forest.

Vaccinium vacillans (Dryland Blueberry). Abundant in pine-oak forest and upland oak forest; occasional (locally common) in pine-beech forest, terrace forest, and bluff forest; occasional in pine stands; rare (locally common) in pine fields; rare in hedgerows.

PRIMULACEAE

Lysimachia ciliata (Fringed Loosestrife). *Steironema ciliatum* of *Gray's Manual*. Occasional (locally common) in bottomland forest.

Lysimachia lanceolata (Lance-leaf Loosestrife). *Steironema lanceolatum* of *Gray's Manual*. Rare in wet meadows; one station in sweetgum field.

Lysimachia nummularia (Moneywort). Locally common in bottomland forest.

Lysimachia quadrifolia (Whorled Loosestrife). Occasional in forest openings, hedgerows, and wood margins.

Lysimachia terrestris (Swamp-candle). Includes *L. producta* of *Gray's Manual*. Occasional (locally common) in wet meadows.

Anagallis arvensis (Pimpernel). Occasional in fallow fields and cultivated fields.

EBENACEAE

Diospyros virginiana (Persimmon). Occasional (locally common) in hedgerows and wood margins; rare in sweetgum fields, seepage swamps, and pine fields.

OLEACEAE

Fraxinus americana (White Ash). Occasional (locally common) in bottomland forest; rare in river swamps, sweetgum fields, and hedgerows.

Fraxinus biltmoreana (Biltmore Ash). Rare in bottomland forests.

Fraxinus pennsylvanica (Red Ash). Occasional (locally common) in river swamps; rare in bottomland forest.

Chionanthus virginica (Fringe-tree). Occasional in seepage swamps; rare in transition swamps, bottomland forest, terrace forest, and bluff forest.

GENTIANACEAE

Sabatia angularis (Rose-gentian). Rare in sweetgum fields, abandoned fields, and pine fields.

Gentiana clausa (Closed Gentian). *G. saponaria*, in part, of *Gray's Manual*—see *Rhodora* **19**:149. 1917. Occasional in wet meadows, sweetgum fields, and immature seepage swamps; rare in seepage swamps and damp hedgerows.

Bartonia paniculata. Rare in seepage swamps.

APOCYNACEAE

Apocynum cannabinum var. *pubescens* (Indian-hemp). Common in sweetgum fields and pine fields; occasional in abandoned fields; rare in fallow fields and cultivated fields.

ASCLEPIADACEAE

Asclepias amplexicaulis (Bluntleaf Milkweed). Rare in abandoned fields and pine fields.

Asclepias pulchra (Hairy Milkweed). *A. incarnata* var. *pulchra* of *Gray's Manual.* Occasional in wet meadows and sweetgum fields.

Asclepias syriaca (Common Milkweed). Occasional in fallow fields and abandoned fields.

Asclepias tuberosa (Butterfly-weed). Rare in abandoned fields and pine fields.

Acerates viridiflora (Green Milkweed). Rare in abandoned fields.

CONVOLVULACEAE

Ipomoea hederacea (Ivy-leaf Morning-glory). Rare in fallow fields and cultivated fields.

Ipomoea lacunosa (Small-flowered Morning-glory). Occasional (locally common) in cultivated fields; rare in fallow fields.

Ipomoea pandurata (Wild Sweet-potato). Rare in abandoned fields and cultivated fields on terrace.

Ipomoea purpurea (Common Morning-glory). Occasional (locally common) in cultivated fields; rare in fallow fields.

Convolvulus sepium (Hedge Bindweed). Rare in abandoned fields and pine fields.

Cuscuta compacta. Two stations: on Winterberry and Lycopus in transition swamp and on Shining Sumac in wood margin.

Cuscuta gronovii. Common (locally abundant) on Wood-nettle and Touch-me-not in bottomland forest.

Cuscuta pentagona. C. arvensis of *Gray's Manual.* Common at one station on Sericea Lespedeza in abandoned field.

POLEMONIACEAE

Phlox maculata (Wild Sweet-William). Rare in damp hedgerows and wood margins.

HYDROPHYLLACEAE

Hydrophyllum virginianum (Virginia Waterleaf). Rare in bottomland forest.

BORAGINACEAE

Myosotis laxa (Forget-me-not). Rare in runs on flood plain; one station in wet meadow.

Mertensia virginica (Virginia Bluebells). Occasional in bottomland forest.

VERBENACEAE

Verbena hastata (Blue Vervain). Occasional in wet meadows and damp wood margins; rare in sweetgum fields.

Verbena simplex (Narrowleaf Vervain). *V. angustifolia* of *Gray's Manual.* Rare in abandoned fields.

Verbena urticaefolia (White Vervain). Rare in abandoned fields, hedgerows, and wood margins.

LABIATAE

Teucrium canadense (Wood-sage). Occasional in wood margins on flood plain.

Trichostema dichotomum (Blue-curls). Common in fallow fields and abandoned fields and along hedgerows and wood margins; occasional in pine fields; rare in sweetgum fields, cultivated fields, and lawns.

Scutellaria integrifolia (Hyssop Skullcap). Occasional in wet meadows; rare in sweetgum fields and damp hedgerows.

Scutellaria lateriflora (Mad-dog Skullcap). Occasional along shore of Cash Lake; rare in open shrub swamps and river swamps.

Scutellaria ovalifolia (Hairy Skullcap). *S. pilosa* of *Gray's Manual.* Rare in wood margins.

Nepeta hederacea (Ground-ivy). Rare in abandoned yards; one station in lawn.

Prunella vulgaris (Heal-all). Common in hedgerows and wood margins; occasional in abandoned fields; rare in fallow fields, pine fields, and lawns.

Lamium amplexicaule (Henbit). Rare in fallow fields and lawns.

Leonurus cardiaca (Motherwort). One station in fallow field.

Stachys hispida. S. tenuifolia var. *aspera* of *Gray's Manual.* One station along road.

Stachys hyssopifolia. One station in roadside ditch.

Monarda punctata (Horse-mint). Common at one station in pine field on terrace.

Hedeoma pulegioides (Pennyroyal). Occasional in wood margins; rare in cultivated fields, lawns, and hedgerows.

Satureja vulgaris (Wild-basil). Rare in hedgerows.

Pycnanthemum flexuosum. Occasional (locally common) in wet meadows and sweetgum fields; occasional in abandoned fields and pine fields.

Pycnanthemum incanum. Rare in bluff forest.

Pycnanthemum muticum. Occasional in wet meadows; rare in sweetgum fields, abandoned fields, and pine fields.

Pycnanthemum verticillatum. Rare in bluff forest.

Cunila origanoides (Dittany). Rare in pine-oak forest; one station in upland oak forest.

Lycopus americanus. Rare in wet meadows.

Lycopus rubellus. One station in bottomland forest.

Lycopus uniflorus. One station in wet meadow.

Lycopus virginicus. Occasional in damp hedgerows and wood margins; rare in sweetgum fields.

Mentha arvensis (Wild Mint). Occasional in wet meadows.

Collinsonia canadensis (Horse-balm). Occasional (locally common) in bottomland forest; one station in terrace forest.

Perilla frutescens (Perilla). Rare in bottomland forest.

SOLANACEAE

Solanum carolinense (Horse-nettle). Common in fallow fields and cultivated fields; rare in sweetgum fields, abandoned fields, pine fields, and pastures.

Solanum nigrum (Black Nightshade). Rare in fallow fields.

Physalis subglabrata (Ground-cherry). Rare in fallow fields.

Datura stramonium (Jimson-weed). Occasional in fallow fields; rare in cultivated fields.

SCROPHULARIACEAE

Verbascum blattaria (Moth Mullein). Rare in abandoned fields and pine fields.

Verbascum thapsus (Common Mullein). Rare in sweetgum fields, abandoned fields, and pine fields.

Linaria canadensis (Blue Toadflax). Occasional in fallow fields, abandoned fields, and pine fields.

Chelone glabra (White Turtlehead). Occasional in river swamps; one station each in shrub swamp and transition swamp.

Mimulus alatus. Occasional (locally common) in river swamps.

Mimulus ringens. Rare in wet meadows.

Lindernia anagallidea. *Ilysanthes anagallidea* of *Gray's Manual*. Locally common in south end of Lake Redington in 1946; rare in wet meadows.

Lindernia dubia. *Ilysanthes dubia* of *Gray's Manual*. Occasional in wet meadows.

Gratiola neglecta. *G. virginiana* of *Gray's Manual*. Occasional in wet meadows.

Gratiola virginiana. *G. sphaerocarpa* of *Gray's Manual*. Rare in pools in runs on flood plain.

Veronica arvensis (Corn Speedwell). Occasional in fallow fields, hayfields, pastures, and lawns.

Veronica officinalis (Common Speedwell). Occasional in hedgerows and wood margins; rare in abandoned fields, pine fields, pastures, and lawns.

Veronica peregrina (Purslane Speedwell). Rare in damp pastures; one station in garden.

Veronica persica (Birds-eye Speedwell). *V. tournefortii* of *Gray's Manual*. Common at one station in fallow field; another station in lawn.

Veronica serpyllifolia (Thyme-leaf Speedwell). Rare in damp pastures, lawns, hedgerows, and wood margins.

Aureolaria virginica (False-foxglove). *Gerardia flava* of *Gray's Manual*. Rare in terrace forest, bluff forest, and upland oak forest.

Gerardia decemloba. *G. parvifolia* of *Gray's Manual*. One station in abandoned field.

Gerardia purpurea (Purple Gerardia). Occasional (locally common) in wet meadows and sweetgum fields; rare in abandoned fields and pine fields.

Melampyrum lineare (Cow-wheat). Occasional in open terrace forest and bluff forest; rare in pine-oak forest and upland oak forest.

Pedicularis lanceolata (Swamp Lousewort). One plant in open shrub swamp.

LENTIBULARIACEAE

Utricularia geminiscapa. *U. clandestina* of *Gray's Manual*. Occasional (locally abundant) in Cash Lake, gravel pit ponds, and experimental plant ponds; rare in slow brooks.

Utricularia gibba. One station in gravel pit pond.

Utricularia vulgaris (Common Bladderwort). One station in south end of Cash Lake.

OROBANCHACEAE

Epifagus virginiana (Beech-drops). Common (locally abundant) under Beech in terrace forest and bluff forest; rare under Beech in pine-oak forest.

Orobanche uniflora (Cancer-root). Occasional in bottomland forest.

BIGNONIACEAE

Campsis radicans (Trumpet-creeper). *Tecoma radicans* of *Gray's Manual*. Occasional (locally common) in sweetgum fields and pine fields; occasional in abandoned fields, hedgerows, and wood margins; rare in bottomland forest, immature seepage swamps, and cultivated fields.

Catalpa speciosa (Northern Catalpa). One station in bottomland forest.

PHRYMACEAE

Phryma leptostachya (Lopseed). Rare in bottomland forest.

PLANTAGINACEAE

Plantago aristata (Bottle-brush Plantain). Occasional (locally common) in fallow fields; rare in abandoned fields.

Plantago lanceolata (Narrowleaf Plantain). Abundant in fallow fields, pastures, and lawns; occasional in abandoned fields, pine fields, and cultivated fields; rare in sweetgum fields.

Plantago major (Common Plantain). Rare in fallow fields.

Plantago rugelii (Rugel Plantain). Common in fallow fields, pastures, and lawns; rare in cultivated fields; one station in open seepage swamp.

Plantago virginica (Virginia Plantain). Occasional in fallow fields.

RUBIACEAE

Galium aparine (Cleavers). Common (locally abundant) in bottomland forest; rare in seepage swamps; one station in Ailanthus thicket.

Galium circaezans (Wild-licorice). Rare in terrace forest, bluff forest, and upland oak forest; one station in Ailanthus thicket.

Galium obtusum. *G. tinctorium* of *Gray's Manual*. Occasional in bottomland forest; rare in seepage swamps on upland.

Galium pilosum (Hairy Bedstraw). Rare in abandoned fields, pine fields, pine stands, and dry hedgerows and wood margins.

Galium tinctorium. *G. claytoni* of *Gray's Manual*. One station in wet meadow.

Galium triflorum (Sweet Bedstraw). Occasional (locally common) in bottomland forest; one station each in pine stand, upland oak forest, and Ailanthus thicket.

Diodia teres (Poor-Joe). Abundant in fallow fields; common in cultivated fields; occasional in abandoned fields and pine fields.

Mitchella repens (Partridgeberry). Common (locally abundant) in seepage swamps; occasional (locally common) in pine-beech forest, terrace forest, and bluff forest; occasional in pine stands and pine-oak forest.

Cephalanthus occidentalis (Buttonbush). Occasional (locally common) in shrub swamps; occasional in transition swamps and open river swamps; one station in seepage swamp on upland.

Houstonia caerulea (Bluets). Common in wet meadows; occasional in open bottomland forest, sweetgum fields, abandoned fields, and pine fields; rare in open terrace forest.

Houstonia purpurea (Purple Houstonia). Occasional in open bottomland forest, open terrace forest, and open bluff forest.

Oldenlandia uniflora. One station in wet meadow.

CAPRIFOLIACEAE

Lonicera japonica (Japanese Honeysuckle). Common (locally abundant) in hedgerows and wood margins; occasional in transitional swamps, river swamps, bottomland forest, seepage swamps, and abandoned fields; rare in sweetgum fields, pine fields, and pine stands.

Lonicera sempervirens (Trumpet Honeysuckle). One station in seepage swamp.

Viburnum acerifolium (Maple-leaf Viburnum). Occasional in terrace forest and bluff forest; rare in bottomland forest.

Viburnum cassinoides (Withe-rod). Rare in seepage swamps; one station in shrub swamp.

Viburnum dentatum (Arrow-wood). Includes *V. venosum* of *Gray's Manual*. Common in transition swamps and seepage swamps; occasional (locally common) in hedgerows and wood margins; occasional in shrub swamps; rare in river swamps, bottomland forest, sweetgum fields, immature seepage swamps, pine fields, pine stands, terrace forest, and bluff forest.

Viburnum nudum (Swamp Viburnum). Occasional (locally common) in shrub swamps; occasional in transition swamps and seepage swamps.

Viburnum prunifolium (Black-haw). Abundant in bottom forest; rare in river swamps, terrace forest, and damp hedgerows and wood margins.

Sambucus canadensis (Elderberry). Occasional in damp hedgerows and wood margins; rare in shrub swamps, transition swamps, river swamps, and bottomland forest.

VALERIANACEAE

Valerianella olitoria ? (Corn-salad). *V. locusta* of *Gray's Manual*. One station in cultivated field.

CUCURBITACEAE

Sicyos angulatus (Star-cucumber). Rare in bottomland forest.

CAMPANULACEAE

Specularia perfoliata (Venus Looking-glass). Occasional in fallow fields, abandoned fields, and pine fields.

LOBELIACEAE

Lobelia cardinalis (Cardinal-flower). Occasional (locally common) in river swamps; occasional in transition swamps and along runs in bottomland forest.

Lobelia inflata (Indian-tobacco). Occasional in abandoned fields, pine fields, and wood margins; rare in sweetgum fields and fallow fields.

Lobelia puberula (Downy Lobelia). Occasional (locally common) in wet meadows and sweetgum fields; occasional in abandoned fields and pine fields.

Lobelia spicata (Spiked Lobelia). Two stations: abandoned field and wood margin.

COMPOSITAE

Vernonia glauca (Broadleaf Ironweed). One station in abandoned field.

Vernonia noveboracensis (New York Ironweed). Occasional (locally common) in wet meadows; occasional in sweetgum fields and damp hedgerows and wood margins.

Elephantopus carolinianus (Elephants-foot). Rare in hedgerows and wood margins.

Eupatorium album. Occasional in sweetgum fields, abandoned fields, and pine fields; rare in terrace forest.

Eupatorium aromaticum. Three stations: sweetgum field, terrace forest, and upland oak forest.

Eupatorium coelestinum (Mist-flower). Rare in terrace forest; one station each in bottomland forest, fallow field, and abandoned field.

Eupatorium hyssopifolium. Occasional in sweetgum fields, abandoned fields, and pine fields.

Eupatorium perfoliatum (Boneset). Occasional in marsh-meadows and wet meadows; rare in sweetgum fields and damp fallow fields.

Eupatorium pubescens. Occasional in sweetgum fields, immature seepage swamps, abandoned fields, and pine fields.

Eupatorium purpureum (Joe-Pye Weed). Occasional (locally common) in marsh-meadows, wet meadows, sweetgum fields, and damp hedgerows.

Eupatorium rotundifolium. Rare in abandoned fields and pine fields.

Eupatorium torreyanum. Rare in sweetgum fields, abandoned fields, and pine fields.

Eupatorium verbenaefolium. Occasional in abandoned fields and pine fields; one station in river swamp.

Mikania scandens (Climbing Hempweed). Rare in damp wood margins on flood plain; one station in seepage swamp.

Liatris graminifolia (Blazing-star). Occasional in abandoned fields and pine fields.

Grindelia squarrosa (Gum-plant). One station in lawn.

Chrysopsis mariana (Golden-aster). Occasional (locally common) in abandoned fields and pine fields; rare in fallow fields.

Solidago altissima. (Tall Goldenrod). Abundant in sweetgum fields, abandoned fields, and pine fields; occasional in fallow fields.

Solidago bicolor (White Goldenrod). Rare in terrace forest, bluff forest, and upland oak forest.

Solidago caesia (Woodland Goldenrod). Occasional in bottomland forest; rare in terrace forest.

Solidago elliottii (Swamp Goldenrod). One station in open seepage swamp.

Solidago erecta (Slender Goldenrod). Occasional in abandoned fields and pine fields.

Solidago gigantea (Giant Goldenrod). *S. serotina* var. *gigantea* of *Gray's Manual.* One station in margin of river swamp.

Solidago graminifolia (Flat-top Goldenrod). Common in wet meadows, sweetgum fields, and damp hedgerows; occasional (locally common) in fallow fields, abandoned fields, and pine fields.

Solidago juncea (Early Goldenrod). Abundant in abandoned fields and pine fields; common in sweetgum fields; occasional in fallow fields.

Solidago nemoralis (Dwarf Goldenrod). Common (locally abundant) in abandoned fields and pine fields; occasional in sweetgum fields and fallow fields.

Solidago odora (Sweet Goldenrod). Rare in pine fields, open forest on terrace and upland, and wood margins.

Solidago puberula (Downy Goldenrod). Occasional (locally common) in abandoned fields and pine fields; rare in open forest on terrace and upland.

Solidago rugosa (Rough Goldenrod). Includes *S. aspera* of *Gray's Manual.* Abundant in sweetgum fields; common in abandoned fields, pine fields, hedgerows, and wood margins; occasional in immature seepage swamps; rare in fallow fields and open terrace forest.

Aster divaricatus (Wood Aster). Occasional (locally common) in bottomland forest; rare in terrace forest.

Aster dumosus. Rare in wet meadows, seepage swamps, fallow fields, and damp hedgerows.

Aster infirmus. One station in dry wood margin.

Aster lateriflorus. Occasional in sweetgum fields; rare in pine fields, hedgerows, and wood margins.

Aster linariifolius (Savory-leaf Aster). Rare in dry wood margins.

Aster paniculatus. Rare in wet meadows and damp hedgerows and wood margins.

Aster patens (Purple Aster). One station in hedgerow.

Aster pilosus. A. ericoides of *Gray's Manual.* Abundant in abandoned fields and pine fields; occasional (locally common) in fallow fields; occasional in wet meadows, sweetgum fields, and pastures.

Aster puniceus (Swamp Aster). Occasional in wet meadows.

Aster umbellatus (Flat-top Aster). One station in sweetgum field.

Aster undulatus. Rare in terrace forest and upland oak forest.

Aster vimineus. Common (locally abundant) in river swamps and openings in bottomland forest and low terrace forest; occasional (locally common) in sweetgum fields; occasional in fallow fields and abandoned fields; rare in wet meadows and pine fields.

Erigeron annuus. Common in fallow fields; occasional in abandoned fields.

Erigeron canadensis (Horseweed). Common (locally abundant) in fallow fields and cultivated fields.

Erigeron strigosus. *E. ramosus* of *Gray's Manual*. Common in fallow fields; occasional in abandoned fields and pastures.

Sericocarpus asteroides (Broadleaf Sericocarpus). Occasional in pine fields and pine stands.

Seriococarpus linifolius (Narrowleaf Sericocarpus). Occasional (locally common) in abandoned fields and pine fields.

Pluchea petiolata (Marsh Fleabane). One station in bottomland forest.

Antennaria neglecta. Occasional (locally common) in pastures; occasional in abandoned fields and pine fields.

Antennaria neodioica. Rare in abandoned fields and pine fields.

Antennaria parlinii. Occasional in abandoned fields and pine fields; rare in hedgerows.

Antennaria plantaginifolia. One station in upland oak forest.

Gnaphalium obtusifolium (Sweet Everlasting). *G. polycephalum* of *Gray's Manual*. Common (locally abundant) in fallow fields; occasional (locally common) in sweetgum fields, abandoned fields, pine fields, and pastures.

Gnaphalium purpureum (Early Cudweed). Occasional in fallow fields; rare in abandoned fields.

Ambrosia elatior (Ragweed). *A. artemisiifolia* of *Gray's Manual*. Abundant in fallow fields and cultivated fields; occasional in pastures; rare in sweetgum fields, abandoned fields, and pine fields.

Ambrosia trifida (Giant Ragweed). Rare in open bottomland forest and fallow fields.

Xanthium pungens (Cocklebur). *X. canadense* of *Gray's Manual*. Occasional in fallow fields and cultivated fields.

Eclipta alba. Rare in wet meadows.

Rudbeckia hirta (Black-eyed Susan). Occasional in fallow fields and abandoned fields; rare in pine fields.

Rudbeckia laciniata (Tall Coneflower). Occasional (locally common) in bottomland forest.

Helianthus angustifolius (Swamp Sunflower). One station in damp wood margin.

Helianthus decapetalus (Thin-leaf Sunflower). Rare in bottomland forest.

Helianthus giganteus (Giant Sunflower). Rare in sweetgum fields and damp wood margins.

Helianthus tuberosus (Jerusalem-artichoke). One station in fallow field.

Actinomeris alternifolia (Yellow Ironweed). Rare in open bottomland forest.

Coreopsis verticillata (Coreopsis). Two stations: pine field and upland oak forest.

Bidens aristosa (Sunflower Beggar-ticks). One station in wet meadow.

Bidens bipinnata (Spanish-needles). Rare in fallow fields.

Bidens connata (Swamp Beggar-ticks). Occasional in wet meadows; rare in damp wood margins on flood plain.

Bidens frondosa (Common Beggar-ticks). Abundant in south end and along west shore of Lake Redington in 1946; occasional (locally common) in wet meadows and fallow fields.

Bidens vulgata (Tall Beggar-ticks). Rare in damp hedgerows and wood margins; one station in abandoned field.

Galinsoga ciliata (Quickweed). *G. parviflora* var. *hispida* of *Gray's Manual.* Common at one station in fallow field.

Helenium autumnale. Rare in wet meadows.

Helenium nudiflorum. Rare in abandoned fields and damp wood margins; one station in lawn.

Achillea millefolium (Yarrow). Common in abandoned fields and pine fields; occasional in fallow fields; rare in sweetgum fields.

Anthemis arvensis (Corn Camomile). Occasional (locally common) in fallow fields.

Anthemis cotula (Mayweed). Rare in fallow fields.

Chrysanthemum leucanthemum (Daisy). Abundant in abandoned fields; common in pine fields; occasional in fallow fields; rare in sweetgum fields, cultivated fields, pastures, and lawns.

Erechtites hieracifolia. Occasional (locally common) in cleared shrub swamps; rare in fallow fields and wood margins.

Cacalia atriplicifolia (Indian-plantain). One station in terrace forest.

Senecio aureus (Golden Ragwort). Occasional in bottomland forest.

Senecio smallii. Rare in abandoned fields.

Arctium minus (Burdock). Rare in yards.

Cirsium arvense (Canada Thistle). One station in fallow field.

Cirsium discolor (Field Thistle). Rare in fallow fields, abandoned fields, and hedgerows.

Cirsium lanceolatum (Bull Thistle). Rare in fallow fields, abandoned fields, and pine fields.

Cichorium intybus (Chicory). Rare in fallow fields and abandoned fields.

Krigia virginica (Dwarf-dandelion). Occasional (locally common) in abandoned fields, wood margins, and pastures; rare in pine fields.

Hypochaeris radicata (Cats-ear). One station in abandoned field.

Leontodon nudicaulis (Hawkbit). One station in abandoned field.

Chondrilla juncea (Skeleton-weed). Rare in fallow fields.

Taraxacum laevigatum (Red-seeded Dandelion). *T. erythrospermum* of *Gray's Manual.* One station along road.

Taraxacum officinale (Dandelion). Occasional in pastures and lawns.

Sonchus asper (Sow-thistle). One station in fallow field.

Lactuca canadensis. Occasional (locally common) in abandoned fields and wood margins; rare in hedgerows.

Lactuca floridana. Rare in damp wood margins.

Lactuca serriola (Prickly Lettuce). *L. scariola* of *Gray's Manual*. Rare in fallow fields.

Lactuca spicata. Rare in damp wood margins.

Lactuca villosa. One station in damp wood margin.

Prenanthes serpentaria (Rattlesnake-root). Rare in damp hedgerows and wood margins.

Hieracium aurantiacum (Devils-paintbrush). One station in abandoned field.

Hieracium gronovii (Hairy Hawkweed). Occasional (locally common) in abandoned fields, pine fields, pastures, and wood margins.

Hieracium paniculatum (Panicled Hawkweed). Rare in terrace forest.

Hieracium pratense (Field Hawkweed). One station in abandoned field.

Hieracium scabrum (Rough Hawkweed). Rare in terrace forest, hedgerows, and wood margins.

Hieracium venosum (Rattlesnake-weed). Rare in terrace forest and upland oak forest.

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U. S. DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE,
PATUXENT RESEARCH REFUGE,
LAUREL, MARYLAND.

An Enumeration of Illinois Pteridophyta

George Neville Jones

Introduction

The purposes of this enumeration are to summarize and clarify our knowledge of the occurrence of species of ferns and fern-allies in Illinois; to account for binomials accredited to Illinois during the past one hundred and fifty years; and to cite specimens to authenticate the county distribution.

The present study includes 64 species in 27 genera and 10 families. In order to make it more useful, keys and diagnostic descriptions for families, genera, and species are provided. In the treatment of species, the valid name with its place of publication, and basonym, as well as a brief synonymy of names that have been applied by Illinois authors, have been included. In addition, bibliographical references, type locality, habitats of species in Illinois, and a statement of the total known geographical distribution are given briefly, as well as local distribution, so far as it is known, in Illinois by counties. The method of indicating general distribution of species has been adapted from Rydberg's *Flora of the Prairies and Plains.*

A number of articles, monographs, and books have been consulted frequently during the preparation of this paper. These are included in the bibliography. The following books have been of particular use: M. Broun, *Index to North American Ferns,* W. R. Maxon, *Pteridophyta* in the second edition of Britton & Brown's Illustrated Flora, J. K. Small, *Ferns of the Southeastern States,* R. M. Tryon, N. C. Fassett, et al., *Ferns and Fern-allies of Wisconsin,* and E. T. Wherry, *Guide to Eastern Ferns.*

Cited specimens, unless otherwise indicated, are in the herbarium of the University of Illinois. Other material has been studied and some of it cited. principally from Chicago Natural History Museum (FM), Illinois Natural History Survey (NHS), Illinois State Museum (SM), Missouri Botanical Garden (MBG), and Peoria Academy of Science (PAS). Thanks are due V. H. Chase, R. A. Evers, G. D. Fuller, J. M. Greenman, P. C. Standley, J. A. Steyermark, and L. R. Tehon for their kind permission to incorporate data from this material into the present study. I should also make grateful acknowledgment to Professor C. A. Weatherby of the Gray Herbarium for his many helpful suggestions, and to Dr. E. W. Fell of Rockford, Illinois, for information concerning the fern-flora of his district.

Taxonomic Treatment

Division I. Pteridophyta Cohn (1872). Fern & Fern-allies

Plants terrestrial, epiphytic, or aquatic, of two distinct alternating generations: sporophyte and gametophyte. Sporophyte normally with root, stem, leaf, and vascular tissue, usually lacking active cambium; venation commonly free

or single, occasionally reticulate. Gametophyte bearing antheridia and archegonia; rhizoids non-septate, simple; archegonia partly or wholly within the thallus; sperms coiled, motile, in evident antheridia, or formed within the microspores.

KEY TO FAMILIES

1. Plants attached to the substratum by roots, either growing on land or submerged in water, but not free-floating.
   2. Leaves not quadrifoliolate or clover-like.
      3. Leaves narrow, sessile, 1-veined, subulate or linear or oval, simple, not "fern-like."
         4. Leaves not whorled; stem solid, not conspicuously jointed.
            5. Stems elongated, leafy.
               6. Cones terete (or in some species the sporangia borne in the axils of ordinary leaves); spores of only one kind, small; leaves without a ligule ..... 1. Lycopodiaceae
               6. Cones more or less 4-angled; spores of two kinds, large (megaspores), and small (microspores), borne in different sporangia in the same cone; ligule present ..... 2. Selaginellaceae
            5. Stem short, thick, corm-like; leaves rush-like, in a basal tuft; plants aquatic or growing in wet soil ..... 3. Isoetaceae
         4. Leaves whorled, united to form toothed sheaths at the conspicuous nodes on grooved, usually hollow stems; sporangia in a terminal cone ..... 4. Equisetaceae
      3. Leaves usually broad and "fern-like" in most species, petiolate, often compound, with numerous or several free (rarely netted) veins.
         7. Small delicate ferns with filmy translucent leaves usually consisting of a single layer of cells; sporangia sessile on a filiform receptacle within a tubular or urceolate indusium ..... 5. Hymenophyllaceae
         7. Larger ferns with the leaves membranous to coriaceous, consisting of several layers of cells; sporangia not as above.
            8. Sporangia large, sessile, opening by a transverse slit, borne in a stalked terminal spike or loose panicle, the sterile blade appearing lateral; vernation erect or inclined ..... 6. Ophioglossaceae
            8. Sporangia small, stalked, borne in clusters (sori) on the back of ordinary or modified foliar leaves, or in pod-like divisions of modified leaves; vernation usually coiled.
               9. Sporangia covering some or all divisions of the fertile leaves, densely crowded, short-stalked, globose, opening by a longitudinal slit into two valves; annulus none; veins free ..... 7. Osmundaceae
               9. Sporangia in sori on the back or margin of ordinary or modified leaves, long-stalked, opening by a nearly complete vertical ring (annulus) ..... 8. Polypodiaceae
   2. Leaves quadrifoliolate, clover-like, long-stalked; sporocarps ovoid, borne at the base of the petioles and containing both megaspores and microspores; plants perennial with slender rhizomes ..... 9. Marsileaceae
1. Plants not attached by roots, minute (5-25 mm. broad), free-floating, leaves imbricated, 2-lobed; sporocarps in pairs beneath the stem ..... 10. Salviniaceae

1. LYCOPODIACEAE Michx.—Clubmoss Family

Perennial terrestrial plants with dichotomously branched roots, elongated stems, and numerous simple sessile evergreen 1-veined often imbricated leaves; ligule none; sporangia compressed, solitary on the base of the inner side of the sporophylls, which are commonly crowded together to form a terminal cone; spores uniform, numerous; gametophyte small, tuberous, mostly hypogean, bisexual; sperms biciliate.

1. LYCOPODIUM L.—Clubmoss

Leaves in 4-16 rows; sporangia flattened, opening by a transverse slit around the margin, borne in the axils of ordinary leaves, or in the axils of modified leaves arranged in a terminal cone; spores sulphur-colored.

1. Sporangia borne in the axils of foliar leaves, not in distinct terminal cones.
   2. Leaves linear-oblanceolate, glossy, widest above the middle, erose-denticulate toward the apex ..... *L. lucidulum*
   2. Leaves lanceolate-linear, widest at the base, nearly or quite entire ..... *L. porophilum*
1. Sporangia borne in terminal cones; sporophylls similar to the foliar leaves ..... *L. inundatum*

LYCOPODIUM LUCIDULUM Michx. Fl. Bor. Am. 2:284 (1803); Vasey (1861) 143; Patterson (1876) 54; Brendel (1887) 89; Huett (1897) 133; Hill (1912a) 42; Pepoon (1927) 153; Stover (1930) 26; Jones (1945) 32.

Type locality.—"Hab. a Canada ad Carolinam montosam."

Range.—Newf.—S.C.—Ala.—Iowa—Minn.

Stems ascending, 10-30 cm. long; leaves linear-oblanceolate, glossy, widest above the middle, erose-denticulate toward the apex, spreading or deflexed, in alternate zones of shorter and longer ones; sporangia 1.5-1.7 mm. long; gemmae usually present. — Shining Clubmoss.

Cool moist woods and ravines, rare.

Specimens examined.—COOK CO.: Without definite locality, *G. Vasey;* Glencoe, *P. Blatchford 2522* (SM). CLARK CO.: Rocky Branch, near Marshall, September 29, 1944, *E. L. Stover.* OGLE CO.: Damp woods, Oregon, August 18, 1884, *M. B. Waite, G. D. Fuller 10240* (SM). WINNEBAGO CO.: Without locality, *M. S. Bebb* (FM); Rockford, *G .D. Fuller 10887* (SM); Roscoe, *G. D. Fuller 10847* (SM).

LYCOPODIUM POROPHILUM Lloyd & Underw. in Bull. Torr. Club 27:150 (1900); Jones (1945) 32.

Lycopodium selago sensu Patterson (1876) 54; Boltwood (1879) 219; Brendel (1887) 89; Hill (1912a) 42. — Non L. (1753).

Type locality.—Putnam Co., Indiana.

Range.—Newf.—Que.—Wis.—Mo.—S.C.

Stems tufted, assurgent or erect, forked, 3-15 cm. or more in length; leaves crowded, spreading or erect, lanceolate-linear, attenuate, nearly or quite entire, widest at the base; sporophylls acuminate, entire, or minutely toothed above the middle; sporangia 1.2-1.5 mm. long; plants often bearing gemmae. — Cliff Clubmoss.

On shaded rocks, often sandstone, rare.

The only published report at hand on intensive field studies of *L. porophilum* in relation to *L. lucidulum* is that of E. J. Hill in 1911. Professor Hill observed, measured, and compared these plants in Wisconsin, and concluded that there is little doubt that they are two distinct species. No "intergrades" were detected, and each preserved its distinctive characters. Hill's conclusions appear to be adequately supported by his series of specimens now in the herbarium of the University of Illinois.

Specimens examined.—COOK CO.: Lake Forest, *G. Vasey* (no number or date). LA SALLE CO.: Without locality, *F. Brendel* (no number or date); near Utica, *Prof Williams* in 1879 (FM). OGLE CO.: Sand rocks, Oregon, June 11, 1885, *M. B. Waite*.

LYCOPODIUM INUNDATUM L. Sp. Pl. 1102 (1753); Higley & Raddin (1891) 151; Hill (1912a) 42; Maxon (1913) 44; Pepoon (1927) 153; Deam (1940) 64; Jones (1945) 32.

Type locality.—"Habitat in Europae inundatis."

Range.—Newf.—Alaska—Ore.—n. Ill.—Md.—W.Va.; Eurasia.

Stems prostrate, slender, leafy, 3-10 cm. long; leaves linear-lanceolate, acuminate, mostly entire, curved upwards; peduncles erect, 2-10 cm. tall, bearing solitary sessile cones 1.5-5 cm. long; sporophylls lanceolate, acuminate, entire, or toothed near the base.

Specimen examined.—COOK CO.: Evanston, September 20, 1890, *L. N. Johnson* (the station since destroyed).

[*Lycopodium annotinum, L. clavatum,* and *L. dendroideum* are attributed to Illinois by Huett (1897), and by Snare & Hicks (1898), but since there are no confirming specimens and Illinois is outside the known range of these species, they can be excluded from the present account.]

2. SELAGINELLACEAE Underw.

Similar to Lycopodiaceae, but heterosporous, the larger sporangia containing 1-4 megaspores, the smaller with numerous microspores; ligule present on the base of the leaf; cones often more or less 4-angled; gametophytes remaining within the spores. Containing only the following genus:

1. SELAGINELLA Beauv.—Selaginella

1. Leaves numerous, uniformly imbricated, many-ranked, subulate, short-awned ..... *S. rupestris*
1. Leaves of two kinds, 4-ranked, spreading in two planes, ovate, acute or cuspidate ..... *S. apoda*

SELAGINELLA RUPESTRIS (L.) Spring in Flora 21:149, 182 (1838); Vasey (1861) 143; Patterson (1874) 18, (1876) 54; Brendel (1887) 89; Gleason (1910) 146; Hill (1912a) 42; Thone (1925) 101; Pepoon (1927) 153; Jones (1945) 32; Fuller (1946) 52.

Lycopodium rupestre L. Sp. Pl. 1101 (1753).

Type locality.—"Habitat in Virginia, Canada, Sibiria."

Range.—Me—Minn.—Iowa—Ga.

Plants tufted, 2-6 cm. tall; leaves closely imbricated, linear-lanceolate, bristle-tipped, convex, the keel grooved, the margins ciliate; spike quadrangular. — Rock Spikemoss.

Dry sandstone rocks, local; northern Illinois, extending southward to Henderson and La Salle counties.

Specimens examined.—HENDERSON CO.: Without definite locality, *M. S. Bebb* (no number or date). JO DAVIESS CO.: Hanover, *Gleason & Gates 2531*. LA SALLE CO.: Dry sandstone hill, Starved Rock, *Agnes Chase 1584, G. N. Jones 15786;* rocks, and on sand, Utica, July 13, 1901, *E. J. Hill*. OGLE CO.: Dry exposed sandstone, White Pines Forest State Park, *Alice L. Hills 3257;* exposed sandstone rocks, Liberty Hill, Oregon, July 8, 1905, *E. J. Hill;* Castle Rock, *G. D. Fuller 10888* (SM).

SELAGINELLA APODA (L.) Fern. in Rhodora **17**:68 (1915); Jones (1945) 32.

Lycopodium apodum L. Sp. Pl. 1105 (1753).

Selaginella apus (L.) Spring ex Mart. Fl. Bras. **12**:119 (1840). Patterson (1876) 54; Brendel (1887) 65; Higley & Raddin (1891) 152; Hill (1912a) 42; Pepoon (1927) 154.

Type locality.—"Habitat in Carolina, Virginia, Pensylvania."

Range.—Me.—B.C.—Tex.—Fla.

Stems soft, tufted, creeping, 2-10 cm. long; leaves thin, ovate, oblique; spikes 5-15 mm. long, the sporophylls ovate, acute. — Creeping Selaginella.

Moist soil, local.

Specimens examined.—COLES CO.: Seep swamp, Charleston, *H. Thut*, September, 1943. COOK CO.: Low sandy ground, Hyde Park, Chicago, June 19, 1885, *E. J. Hill;* Chicago, *J. M. Greenman 2607, 3585* (MBG). FULTON CO.: Canton, *J. Wolf* (SM). KANE CO.: Aurora, September 7, 1879, *T. E. Boyce;* Elgin, *G. Vasey* (no number or date). KANKAKEE CO.: Springy ground among grass, Kankakee, *E. J. Hill*, June 1871. LAKE CO.: Peaty soil of wet meadow, Irving Lake, Grant Tp., August 25, 1908, *E. J. Hill*. PEORIA CO.: Peoria, *F. Brendel* (no number or date); low grassy spot near Dry Run, Bradley Park, Peoria, *V. H. Chase 6739* (PAS). ST. CLAIR CO.: Belleville, June 1834, *G. Engelmann 131* (MBG). TAZEWELL CO.: Without locality, *V. H. Chase 3160* (PAS). VERMILION CO.: Near Oakwood, *G. N. Jones 14381;* springy ground on wooded hillside near Oakwood, *G. N. Jones 13849*. WABASH CO.: Mt. Carmel, March 15, 1877, *John Groff*. WILL CO.: Low peaty ground, Troy, September 15, 1911, *E. J. Hill*.

3. ISOETACEAE Underw. — Quillwort Family

Small perennial aquatic or terrestrial rush-like plants with dichotomously branched roots, short corm-like stems, and numerous, simple, linear, sessile, tufted leaves; ligule present; spores of two kinds (microspores and megaspores) in solitary adaxial sporangia enclosed in the bases of the leaves and more or less covered by a membranous indusium formed by the infolded leaf-margins (velum); gametophytes remaining within the spores; sperms multiciliate. Only the following genus:

1. ISOETES L. — Quillwort

1. Megaspores 0.3-0.4 mm. in diameter, nearly smooth, or with low tubercles ..... *I. melanopoda*

1. Megaspores 0.4-0.6 mm. in diameter, reticulated ..... *I. engelmann*

ISOETES MELANOPODA Gay & Dur. in Bull. Soc. Bot. France 11:102 (1864); Patterson (1876) 54; Brendel (1887) 89; Higley & Raddin (1891) 152; Huett (1897) 133; A. A. Eaton (1908) 61; Hill (1912a) 43; Maxon (1913) 54; Pfeiffer (1922) 149; Pepoon (1927) 154; Rydberg (1932) 20; Fassett (1940) 47; Muenscher (1944) 343; Jones (1945) 32.

Type locality.—Athens, Illinois. Collected by E. Hall.

Range.—Iowa—Okla.—e. Tex.—La.—Ill.; also Cape May Co., N. J.

Plants emersed; leaves 15-60, 1.5-3.5 mm. broad, 12-45 cm. long, blackish at base; stomata present; microspores finely spinulose, ashy-gray.

Wet meadows or shallow ponds, chiefly in the western part of the state; rare, or perhaps now extinct in Illinois, since apparently the most recent collection is that of Mr. V. H. Chase in 1908. (*V. H. C. no. 1882*).

Specimens examined.—FULTON CO.: Without definite locality, *J. Wolf* in 1874. LOGAN CO.: Lincoln, April 8, 1881, *F. Foerste.* MCHENRY CO.: Ringwood, *G. Vasey* in 1863. MENARD CO.: Ponds, Athens, *E. Hall* in 1861, and November 25, 1865. ST. CLAIR CO.: Bluffs Lake, *H. Eggert*, June 1881 (MBG); banks of a pond, East St. Louis, August 9, 1882, *H. Eggert* (MBG). STARK CO.: Drying bed of shallow pond, Wady Petra, *V. H. Chase 136;* shallow pond, Wady Petra, *V. H. Chase 1882.*

ISOETES ENGELMANNI A.Br. in Flora 29:178 (1846); Maxon (1913) 53; Pfeiffer (1922) 201; Fassett (1940) 47; Muenscher (1944) 343; Jones (1945) 32.

Type locality.—St. Louis, Missouri. Collected by Geo. Engelmann in 1842.

Range.—Me.—Ga.—Mo.

Leaves 10-40, 1-2 mm. in diameter, 10-40 cm. long, pale green; stomata present, at least near the apex of the leaf; microspores smooth or nearly so.

Ponds, rare; St. Clair Co., *H. Eggert* (MBG).

[*Isoetes butleri* Engelm., attributed to Illinois by Hill (1912a) 43, on the authority of A. A. Eaton (1908) 61, appears to be an error for *I. melanopoda.*]

4. EQUISETACEAE Michx. — Horsetail Family

Perennial rush-like plants with rhizomes; stems annual or perennial, distinctly jointed, hollow, cylindrical, longitudinally grooved; leaves small, simple, sessile, appressed, 1-veined, whorled and united to form a sheath; sporophylls numerous, arranged in a terminal cone. Containing only the following genus:

1. EQUISETUM L.

1. Stems all alike, usually simple; stomata in regular rows in the grooves.
   2. Stems usually tall, 10-50 angled, hollow; teeth of the sheaths soon deciduous.
      3. Sheaths about as long as broad, short-cylindrical, appressed, ashy-gray, with a black band near the base; stems dark green, perennial, rough-tuberculate; cones rigidly apiculate ..... *E. hyemale*
      3. Sheaths slightly longer than broad, dilated upward and somewhat funnelform, green, and usually with a narrow black rim; stems pale, annual, smooth or nearly so; cones blunt or with a small apiculus ..... *E. laevigatum*
   2. Stems low, slender, 5-10 angled; teeth of the sheaths persistent; cones apiculate.

4. Stems 15-30 cm. tall, 1-3 mm. thick, 5-10 angled; central cavity one-third the diameter of the stem; sheaths 5-10-toothed; cones 5-10 mm. long ..... *E. variegatum*

4. Stems 5-15 cm. tall, 0.5-1 mm. thick, 6-angled; central cavity absent; sheaths mostly 3-toothed; cones 3-5 mm. long ..... *E. scirpoides*

1. Stems annual, flexible; stomata scattered; cones blunt.

5. Stems all alike, green, usually branched at maturity.

6. Stems 10-30 angled; central cavity one-half or more the diameter of the stem; sheaths tight ..... *E. fluviatile*

6. Stems 5-10-angled; central cavity about one-sixth the diameter of the stem; sheaths loose ..... *E. palustre*

5. Stems of two kinds, the sterile green and branched, the fertile whitish or brownish, appearing in early spring and soon withering ..... *E. arvense*

EQUISETUM HYEMALE L. Sp. Pl. 1062 (1753); Mead (1846) 121; Lapham (1857) 549; Patterson (1876) 53; Brendel (1887) 64; Higley & Raddin (1891) 149; Huett (1897) 131; Snare & Hicks (1898) 25; Hill (1912a) 41; Gleason (1910) 146; Gates (1922) 165; Thone (1925) 101; Pepoon (1927) 152.

Equisetum prealtum Raf. Fl. Ludov. 13 (1817); Fuller (1943) 91; Jones (1945) 33; Fuller (1946) 52.

Equisetum robustum A.Br. ex Engelm. in Am. Journ. Sci. **46**:88 (1844); Lapham (1857) 549; Patterson (1876) 53; Brendel (1887) 64; Gleason (1907) 181; Hill (1912a) 41.

Equisetum robustum var. *affine* Engelm. in op. cit.

Equisetum hyemale var. *affine* (Engelm.) A. A. Eaton in Fern Bull. **11**:75, 111 (1903).

Equisetum hyemale var. *robustum* (A.Br.) A. A. Eaton in op. cit.; Pepoon (1927) 152.

Equisetum ferrissi Clute in Fern Bull. **12**:22 (1904); Hill (1912a) 41.

Equisetum affine (Engelm.) Rydb. Fl. Rocky Mts. 1052 (1917), also (1932) 19.

Type locality.—"Habitat in Europae sylvis, asperis, uliginosis."

Range.—Que.—Md.—La.—Tex.—Calif.—B.C.; Mexico. Eurasia.

Stems 0.5-1 m. tall, 3-15 mm. thick, evergreen, 10-50-angled, the internodal ridges roughened with one or two rows of siliceous tubercles; sheaths short-cylindrical, ashy-gray, usually with two dark bands, the teeth soon deciduous; cones 1-2.5 cm. long. — Tall Scouring-rush.

Moist sandy soil, occurring probably in every county in Illinois. Slender specimens have been named as species or varieties, but all intergrades between slender and robust plants are found. The slender plants grow in drier soil, or among cinders along railroads.

American plants often have been regarded as specifically or varietally distinct from the European. They are said to be distinguished by the ridges of the stem bearing a single row of tubercles or cross-bands of silica, and the leaves being sharply tricarinate. European plants are said to have usually two distinct rows of tubercles, and the leaves quadricarinate. However, examination under high magnification of a series of specimens from both hemispheres does not reveal any consistent differences in this or other respects. The stems of both

European and American plants appear also to vary equally in thickness and general robustness.

In their apparently evergreen stems with tuberculate ridges, and the short sheaths with dark bands, specimens from the type locality of *E. ferrissi* belong clearly to *E. hyemale,* although there is a sheet labeled *E. ferrissi* in the herbarium of the Chicago Natural History Museum collected by W. N. Clute on a railway embankment near Joliet in 1907 that is *E. laevigatum.*

Specimens examined.—ADAMS CO.: Near Quincy, *Rev. R. Brinker 2658* (NHS). ALEXANDER CO.: Cairo, *H. S. Pepoon 3554* (NHS). CHAMPAIGN CO.: Urbana, October 6, 1898, *G. Gibbs;* high bank along river, Mahomet, September 6, 1899, *G. P. Clinton;* Mahomet, May 30, 1945, *J. L. C. Rapp & W. F. Rapp, G. N. Jones 17488, 17539;* without definite locality, August 13, 1881, *A. B. Seymour.* CHRISTIAN CO.: Taylorville, April 29, 1898, *W. E. Andrews.* COOK CO.: Wet soil, Chicago, *N. L. T. Nelson,* May 1898; bottom of gravel pit at Glenwood Beach, La Grange, November 19, 1901, *E. J. Hill,* and June 3, 1902, also July 26, 1902; South Chicago, *G. H. Shull* in 1902 (PAS). FULTON CO.: Canton, *J. Wolf* (SM). GALLATIN CO.: Shawneetown, *E. J. Palmer 15263* (MBG); New Haven, *E. J. Palmer 15284a* (MBG). HARDIN CO.: Big Creek, June 23, 1931, *J. Schopf* (NHS). JACKSON CO.: Grand Tower, November 5, 1881, *G. H. French & A. B. Seymour.* JERSEY CO.: Elsah, *E. M. Reed,* September 1898 (MBG). JOHNSON CO.: Without definite locality, *F. Brendel* (no number or date). LAKE CO.: Lake Bluff, *W. A. Poyser* in 1910 (MBG). LOGAN CO.: Lincoln, *G. D. Fuller 8773* (NHS, SM). MADISON CO.: Cahokia, June 11, 1890, *A. S. Hitchcock* (MBG). MASON CO.: Lake Matanzas, July 13, 1910, *F. C. Gates.* OGLE CO.: Castle Rock, *G. D. Fuller 10889* (SM); Margin of stream, White Pines Forest State Park, *Alice L. Hills 3258-0.* PEORIA CO.: Peoria, *F. Brendel* (no number or date); moist sandy bank of stream, one mile west of Mossville, *V. H. Chase 7859;* along the brook, Springdale Cemetery, *F. E. McDonald,* May 1889. PIKE CO.: East Hannibal, *J. Davis 6496,* also July 24, 1911; Shepherd, May 3, 1911, *Miss Botter* (MBG). SANGAMON CO.: Auburn, *G. D. Fuller 4997* (SM). UNION CO.: Ware, *Pepoon & Mohr 256* (NHS). VERMILION CO.: Danville, June 24, 1886, *M. B. Waite.* WABASH CO.: Near Mt. Carmel, July 11, 1882, July 25, 1889, July 8, 1906, May 30, 1906, *J. Schneck.* WHITESIDE CO.: Fulton, *F. J. Hermann 8879* (FM). WILL CO.: Wooded slope in Bush Park, Joliet (type locality of *E. ferrissi*), April 5, 1904, *E. J. Hill.*

EQUISETUM LAEVIGATUM A.Br. ex Engelm. in Am. Journ. Sci. **46**:87. (1844); Mead (1846) 121; Lapham (1857) 549; Patterson (1874) 18, (1876) 53; Brendel (1887) 64; Higley & Raddin (1891) 149; Huett 1897) 131; Hill (1912a) 41; Gates (1912) 353; Gates (1922) 165; Pepoon (1927) 152; Jones (1945) 33; Fuller (1946) 52.

Equisetum variegatum sensu Brendel (1859) 585, (1887) 64; Patterson (1876) 53. — Non Schleich. (1807).

Equisetum hyemale var. *intermedium* A. A. Eaton in Fern Bull. **10**:120 (1902); Gleason (1910) 146.

Equisetum hiemale sensu Gates (1912) 353. — Non *E. hyemale* L. (1753).

Equisetum kansanum Schaffner in Ohio Nat. **13**:21 (1912); Schaffner (1921) 72.

Equisetum intermedium (A. A. Eaton) Rydb. Fl. Rocky Mts. 1053 (1917), also (1932) 19.

Equisetum laevigatum forma *proliferum* Haberer in Bull. N. Y. State Mus. **243-244**:47 (1923); Rapp (1946) 19.

Type locality.—". . . on the banks of the [Mississippi] river below St. Louis," Missouri.

Range.—Mass.—B.C.—Calif.—La.—Ga.; Mexico—Guatemala.

Stems annual, erect, 30-100 cm. long, 2-8 mm. thick, simple or branched, smooth or slightly roughened; sheaths slightly longer than broad, dilated and somewhat funnelform, green, and usually with a narrow black rim; cones 8-25 mm. long, 3-8 mm. thick, apiculate or blunt. — Smooth Scouring-rush.

Sandy or alluvial soil, commonly along railroads, occurring throughout Illinois, probably in every county. The plants are eaten by cattle, and are therefore usually browsed off and soon exterminated from pastures. When the stems are cut off, or otherwise injured near the base, smaller stems are produced, resulting in a growth-form similar to that of *E. variegatum*. Several ecological forms of *E. laevigatum* have been described as species and varieties. Scattered throughout Illinois and elsewhere are plants with apiculate cones, and blunt cones, stems that are simple, and many that are branched. These forms are here all included under the binomial *E. laevigatum* because they seem to constitute a fundamentally homogeneous population without evidence of genetical differentiation.

The stems may be single or tufted, simple or occasionally branched, and may attain a height of one meter. In Illinois they begin their growth in April, produce cones from May to July, and by September they dry up and die. New stems appear continuously until the middle of the summer, but all have died before the end of the season. In winter and early spring dead stems are to be found intact upon the ground, spreading in various directions. When disturbed, however, they crumble into small fragments.

In 1903, A. A. Eaton, who later prepared the treatment of this genus for the seventh edition of Gray's Manual, commented on *E. laevigatum* in the Fern Bulletin as follows: "The stems appear to be strictly annual. Not one of the several hundred specimens I have seen has a stem a year old, and I have been unable to find a person who has seen it in early spring. . . . Specimens collected in July or August usually have dead or dying tops. It fruits mostly in May, but may develop secondary stems later and continue its fruiting into mid-summer. Only one label of all I have seen calls it annual." (Fern Bull. 11:42.)

The accuracy of Engelmann's original description of *E. laevigatum* has been questioned by Schaffner (1924), who says that it was described as a perennial-stemmed plant with an apiculate cone, but a careful reading of Engelmann's description shows that it refers unmistakably to the common and widespread species that for more than a century has been named *E. laevigatum*. In the original description Engelmann does not mention the cones, nor does he say whether the aerial stems are annual or perennial, but by implication one may conclude that he regarded his species as having perennial stems because he included it in the group "*Equiseta stichopora* (Winter Equiseta). . . . All the known species of this division have hardy evergreen stems." This is to be expected, since all the members of this group were at that time (1844) thought to be perennial-stemmed. The shape of the cone of *E. laevigatum* has to be inferred from the discussion following the description, where Engelmann mentions casually that "The spikes are generally more obtuse than in *E. hyemale*." In the herbarium of the University of Illinois there are 52 sheets of *E. laevi-*

gatum from Illinois. Of these, 14 are sterile specimens without cones, 18 have apiculate cones, 18 have the cones obtuse, and two collections show both blunt and apiculate cones.*

Specimens examined.—ADAMS CO.: Quincy, *R. A. Evers 140.* CHAMPAIGN CO.: Urbana, *A. B. Seymour* in 1878, *T. J. Burrill* in 1884, *G. N. Jones 11632, 12663, 12830, 13959, 17416, 17482;* along railroad, Champaign, *G. P. Clinton* in 1900, *M. B. Waite* in 1885. COOK CO.: Sand banks, Colehour, July 6, 1875, *E. J. Hill;* sandy ridges, Thornton, June 19, 1865, *E. J. Hill;* wet woods, Thornton, July 11, 1898, *E. J. Hill;* sandy beach along Lake Michigan, Rogers Park, Chicago, June 15, 1896, *Agnes Chase;* sandy soil, roadside, Hyde Park, Chicago, *Agnes Chase 1572;* DOUGLAS CO.: Along railroad, Tuscola, *G. N. Jones 15072, 17474.* EFFINGHAM CO.; Mason, May 8, 1930, *G. H. Boewe* (NHS). FULTON CO.: Canton, *J. Wolf* (SM). HANCOCK CO.: Denver, *F. C. Gates 8828;* Augusta, *S. B. Mead* in 1845. HENDERSON CO.: Prairies, Oquawka, *H. N. Patterson, September — ——.* HENRY CO.: Along railway track near Galva, *V. H. Chase 1740.* KANKAKEE CO.: Dry banks, Kankakee, June 14, 1873, *E. J. Hill;* gravelly soil, St. Anne, *G. N. Jones 11517.* LAKE CO.: Railroad ballast, Beach, *F. C. Gates 1654;* Waukegan, *F. C. Gates 3041, C. F. Millspaugh & O. E. Lansing 34* (FM). LEE CO.: Dixon, June 6, 1939, *Hawkins & Anderson* (NHS). LIVINGSTON CO.: Alluvial soil, without definite locality, *G. D. Fuller 9216.* MACON CO.: Railroad right-of-way, without definite locality, *I. W. Clokey 2418.* MACOUPIN CO.: Carlinville, June 6, 1894, *W. E. Andrews.* MADISON CO.: Venice, *F. Wislizenus 432* (MBG). MARSHALL CO.: Wenona, *G. N. Jones 16965.* MASON CO.: Lake Matanzas, *F. C. Gates 3751.* MCHENRY CO.: Algonquin, *W. A. Nason* in 1878. MCLEAN CO.: Normal, July 26, 1881, *A. B. Seymour.* MENARD CO.: Prairies, Athens, *E. Hall* in 1861. MORGAN CO.: Sandy soil, Concord, *F. E. McDonald* in 1904. PEORIA CO.: Peoria, *F. Brendel,* without date or number; damp clay soil, *F. E. McDonald,* July 1889, clay bank of stream, Princeville, June 13, 1896, *V. H. Chase.* PERRY CO.: Pinckneyville, *E. J. Palmer 17088* (MBG). PIKE CO.: East Hannibal, *J. Davis 6496.* ST. CLAIR CO.: Without definite locality, *F. Brendel* in 1850. SANGAMON CO.: Mechanicsburg, *G. D. Fuller 3445* (NHS). STARK CO.: Railway embankment near Wady Petra, *V. H. Chase 1514.* UNION CO.: Shawnee National Forest, *G. D. Fuller 792.* WABASH CO.: Old Palmyra, May 28, 1880, *J. Schneck.* WHITESIDE CO.: Morrison, July 17, 1945, *G. H. Boewe* (NHS). WILL CO.: Railroad embankment, Joliet, June 28, 1907, *E. J. Hill.* WINNEBAGO CO.: Clay ponds, Rockford, *G. D. Fuller 16694.* WOODFORD CO.: Sandy bank, Worth, *V. H. Chase 6308* (PAS).

EQUISETUM VARIEGATUM Schleich. ex Web. & Mohr, Bot. Taschenb. 60, 447 (1807); in Cat. Pl. Helvet. 21 (1800), nom. nud.; ibid. ed. 2, 27 (1807), nom. attrib. to "All.".—Vasey (1861) 143; Brendel (1887) 64; Hill (1912a) 42; Schaffner (1921) 72; Jones (1945) 33; Fuller (1946) 52.

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* It is instructive to note here that *Equisetum fontinale* E. B. Copeland, Madroño **3**:367 (1936), an annual-stemmed Californian plant listed by Broun (1938) as a synonym of *E. kansanum,* bears both apiculate and blunt cones. Copeland says: "[whether] immature or mature spikes be examined, some will be found with rounded and some with pointed apices." His illustration (fig. 1) shows a photograph of two cones from the type collection, one apiculate and the other rounded. If *E. fontinale* is merely another name for *E. laevigatum* and *E. kansanum,* this would seem to be further proof that both types of cones occur in the same species. Even if *E. fontinale* could be proved to be a separate species, the variation in the cone-apices strongly suggests that this character is quite unreliable for diagnostic taxonomic purposes in this group of plants. In fact, Schaffner, Am. Fern Journ. **18**:77 (1928), pointed out that ". . . no absolute reliance can be placed on the presence or absence of the apiculate cone, as in distinguishing between *E. laevigatum* and *E. kansanum.* For although the difference in this character is usually definite, extreme fluctuations overlap and one must, therefore, depend in such cases on the annual and perennial condition of the stems."

Equisetum variegatum var. *jesupi* A. A. Eaton ex Gilb. List N. Am. Pterid. **9**:27 (1901), also (1908) 54; Hill (1912a) 42.

Equisetum variegatum var. *nelsoni* A. A. Eaton in Fern Bull. **12**:41 (1904) also (1908) 54; Hill (1912a) 42.

Equisetum nelsoni (A. A. Eaton) Schaffner in Am. Fern Journ. **16**:46 (1926); Deam (1940) 62.

Type locality.—Switzerland.

Range.—Lab.—N.Y.—Colo.—Alaska; Eurasia.

Stems slender, tufted, ascending, perennial, 15-40 cm. tall, 5-10-ridged, the ridges with two rows of siliceous tubercles; central cavity small; sheaths loose, variegated with black, the leaves 5-10, persistent, broadly hyaline-margined, the tips attenuate, caducous; cones 5-10 mm. long, sharply apiculate.

Moist sandy soil, locally in the northeastern counties.

Specimens examined.—COOK CO.: Mt. Prospect, *H. C. Benke 6055* (FM); Hinsdale, *E. C. Smith 406* (FM). LAKE CO.: Wet sands, Waukegan, July 5, 1886, *E. J. Hill;* dryish slopes of ravines, Lake Forest, June 9, 1904, *E. J. Hill.*

EQUISETUM SCIRPOIDES Michx. Fl. Bor. Am. **2**:281 (1803); Patterson (1876) 53; Brendel (1887) 89; A. A. Eaton (1908) 54; Hill (1905) 21, (1912a) 42; Maxon (1913) 42; Schaffner (1921) 72; Pepoon (1927) 152; Jones (1945) 33.

Type locality.—"Hab. in vetustis sylvis Canadae." [Quebec].

Range.—Lab.—Pa.—Mont.—Wash.—Alaska; Greenland; Eurasia.

Stems tufted, slender, 5-15 cm. tall, flexuous, solid, 6-angled, the angles roughened with a single row of tubercles; sheaths blackish; leaves 3 at each node, hyaline-bordered, filiform-tipped, persistent; cones 3-5 mm. long.—Dwarf Scouring-rush.

Moist ground, rare.

Specimens examined.—LAKE CO.: North slope of wooded ravine, Lake Bluff, November 22, 1904, *E. J. Hill;* Highwood, *G. D. Fuller 1043* (SM). MCHENRY CO.: Ringwood, *G. Vasey* (no date or number).

EQUISETUM FLUVIATILE L. Sp. Pl. 1062 (1753); Hill (1912a) 41; Pepoon (1927) 151; Fuller (1943) 91; Muenscher (1944) 346; Jones (1945) 33.

Equisetum limosum L. loc. cit.; Brendel (1859) 585; Vasey (1861) 143; Patterson (1876) 53; Brendel (1887) 64; Higley & Raddin (1891) 149; Huett (1897) 131.

Type locality.—"Habitat in Europa ad ripas lacuum, fluviorum."

Range.—Newf.—N. Y.—Va.—Nebr.—Wyo.—Wash.—Alaska. Eurasia.

Stems 50-100 cm. tall, green, erect, 10-30-grooved, commonly branched (simple when young); branches simple, 4-6-angled; sheaths with 15-20 teeth; cones 1-2 cm. long.—Water Horsetail.

Along ditches, shores of ponds and lakes, or in marshes or shallow water, local.

Specimens examined.—COOK CO.: Wet ground, Englewood, July 3, 1877, and May 26, 1881, *E. J. Hill;* banks of ponds, Chicago, *N. L. T. Nelson,* June 1898. DU PAGE CO.: Woods, Warrenville, *W. S. Moffatt 53.* KANKAKEE CO.: Along stream, Saint

Anne, *G. N. Jones 11516.* LA SALLE CO.: Starved Rock State Park, June 12, 1939, *F. G. Werner* (NHS). PEORIA CO.: Peoria, *F. Brendel* (no number or date). ROCK ISLAND CO.: September 10, 1926, *Thompson & Tehon* (NHS). TAZEWELL CO.: Shallow water, Spring Mills,* *F. E. McDonald*, July 1891. WILL CO.: Joliet, *H. C. Skeels 226* (FM). WOODFORD CO.: Bottomland along the Illinois River three miles south of Spring Bay, *C. N. Jones 14314.*

EQUISETUM PALUSTRE L. Sp. Pl. 1061 (1753); Patterson (1876) 53; Brendel (1887) 64; McDonald (1900) 34; Hill (1912a) 41; Maxon (1913) 40; Schaffner (1921) 73; Jones (1945) 33.

Equisetum palustre var. *americanum* Victorin, Equis. du Quebec **51**:121 (1927).

Type locality.—"Habitat in Europae aquosis."

Range.—Newf.—Pa.—Wyo.—Wash.—Alaska; Eurasia.

Stems slender, branched, green, annual, 20-40 cm. tall; cavity less than one-third the diameter of the stem; sheaths loose, 7-8 mm. long, with 7-12 sharp teeth; branches slender, simple, 4-7-angled, hollow, with 4-5-toothed sheaths; cones 1-2.5 cm. long. — Marsh Horsetail.

Wet soil, not common. Sterile stems might be mistaken for those of *E. arvense*, but they can be readily distinguished by the anatomical characters of the stem.

In Illinois, *Equisetum palustre* is known to occur only in the vicinity of Peoria, where it was discovered first by F. Brendel. It is reported by McDonald (1900) to grow abundantly, with *E. fluviatile*, near springs where the water runs over a sandy or gravelly bottom, at the foot of bluffs at the eastern edge of the floodplain of the Illinois River nearly opposite Peoria. McDonald lists the following species of other northern plants growing nearby: *Habenaria huronensis* (Nutt.) Spreng. [*H. hyperborea* sensu Am. auth.], *Mimulus geyeri* Torr. [*M. jamesii* T. & G.], *Lobelia kalmii* L., *Eriopthorum gracile* Roth, *Scleria verticillata* Muhl., and *Berula pusilla* (Nutt.) Fern. [*B. angustifolia* (L.) Mert. & Koch].

Specimens examined.—PEORIA CO.: Peoria,** *F. Brendel* (no number or date). TAZEWELL CO.: Shallow water, Spring Mills, *F. E. McDonald*, July 1891.

EQUISETUM ARVENSE L. Sp. Pl. 1061 (1753); Mead (1846) 121; Lapham (1857) 549; Babcock (1873) 98; Patterson (1874) 18, (1876) 53; Brendel (1887) 64; Higley & Raddin (1891) 149; Huett (1897) 131; Snare & Hicks (1898) 24; Gleason (1907) 181, (1910) 146; Gates (1912) 353; Hill (1912a) 41; Sherff (1913) 593; Schaffner (1921) 74; Thone (1925) 101; Gates (1925) 226; Pepoon (1927) 151; Fuller (1943) 91; Jones (1945) 33; Fuller (1946) 52.

Equisetum pratense sensu Gates (1922) 165; Pepoon (1927) 151. — Non L. (1753).

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* "The Spring Mill bog is in Tazewell County, Illinois. McDonald entered the locality on his notes as Woodford County, but when I called his attention to the matter he assured me that the bog was on the Adam Messer farm in section 22, Fon du Lac Township, Tazewell County, Illinois. By overlooking sundry 'No Trespass' signs you can still find a portion of the bog worth seeing." — V. H. Chase, in litt., May 24, 1941.

** Probably not in Peoria, but across the Illinois River in Tazewell County. Brendel labeled "Peoria" specimens collected anywhere within a radius of fifteen miles of Peoria.

Type locality.—"Habitat in Europae agris pratis."

Range.—Greenl.—S. C.—Calif.—Alaska. Eurasia; N. Africa.

Sterile stems erect or ascending or decumbent, usually 10-40 cm. tall, 10-14 grooved; central cavity more than half the diameter of the stem; sheaths 4-5 mm. long; branches numerous, solid, 3-4-angled; fertile stems short-lived, 5-20 cm. tall; sheaths 8-12-toothed; cones 2-4 cm. long. — Field Horsetail.

Moist sandy soil, common, particularly on railroad embankments.

Specimens examined.—ADAMS CO.: Old drainage ditch, Quincy, *R. A. Evers 107.* ALEXANDER CO.: East Cape Girardeau, *E. J. Palmer 14901* (MBG). CALHOUN CO.: Hardin, August 26, 1930, *Campbell & Alexopoulos* (NHS). CHAMPAIGN CO.: Urbana, November 6, 1898, *G. P. Clinton;* waste places, Urbana, *G. P. Clinton,* May 1899; along railroad, Urbana, May 26, 1900, *G. P. Clinton;* along railroad, Urbana, *G. N. Jones, 11075, 11249, 11629, 13471;* Champaign, May 22, 1885, and June 22, 1886, *M. B. Waite;* along railroad 15 miles west of Urbana, *G. N. Jones 15574, 15614;* Mahomet, May 30, 1945, *J. L. C. Rapp & W. F. Rapp.* CLARK CO.: Rocky Branch, *H. S. Pepoon 5357* (NHS). COLES CO.: Shores of lake, Fox Ridge State Park, *V. A. Anderson 11362.* COOK CO.: Ditch by railroad, Calumet, *Agnes Chase 703;* Chicago, *N. L. T. Nelson,* September 1898; sandy wastes, Chicago, *O. E. Lansing 1658;* Dunning, April 28, 1906, *F. C. Gates;* Leyden, April 30, 1906, *F. C. Gates;* Edgebrook, *F. C. Gates 1085* (FM); railroad embankment, April 26 and May 10, 1897, *Agnes Chase.* DU PAGE CO.: Lisle, July 9, 1898, *L. M. Umbach* (FM). Along railroad, common, Wheaton, *W. S. Moffatt 1795.* EFFINGHAM CO.: Mason, May 8, 1930, *G. H. Boewe* (NHS). FAYETTE CO.: Ramsey, *Louise Odell 5.* FULTON CO.: Canton, *J. Wolf* (SM). GALLATIN CO.: New Haven, *E. J. Palmer 15284* (MBG). HANCOCK CO.: Along railroad, Carthage, *F. C. Gates 8772.* HENDERSON CO.: Oquawka, *H. N. Patterson* (FM). HENRY CO.: Without definite locality, May 2, 1943, *R. J. Dobbs* (NHS). JO DAVIESS CO.: Galena, *O. E. Lansing 4072* (FM). KANE CO.: Banks of Fox River, Aurora, *W. S. Moffatt 878.* KANKAKEE CO.: Wet ground, Kankakee, May 8, 1874, *E. J. Hill,* wet sands, Kankakee, May 2, 1874, *E. J. Hill.* LAKE CO.: Dry ground along railroad, Lake Villa, *Gleason & Shobe 225;* Beach, *O. E. Lansing 3608;* Lake Forest, *M. C. Jensen* in 1896 (MBG). LA SALLE CO.: Starved Rock, *F. Thone 116.* LAWRENCE CO.: St. Francisville, August 22, 1941, *G. H. Boewe* (NHS). LEE CO.: Dixon, *E. Keithley 46* (SM). LIVINGSTON CO.: Pontiac, *G. D. Fuller 8576* (NHS). MACON CO.: Dry ground along railroad, without definite locality, *I. W. Clokey 2419.* MASON CO.: Lake Matanzas, *F. C. Gates 3724, 3753.* McHENRY CO.: Algonquin, *W. A. Nason,* May ..... McLEAN CO.: Funks Grove, *G. D. Fuller 7671* (NHS). MENARD CO.: River banks, without definite locality, *E. Hall* in 1861. OGLE CO.: White Pines Forest State Park, May 20, 1942, *Alice L. Hills* (SM). PEORIA CO.: Railroad embankment, Akron, *V. H. Chase* in 1896; Peoria, *F. Brendel* (no number or date); moist ground, Peoria, *F. E. McDonald,* May 1889. ROCK ISLAND CO.: Cordova, *J. Monell* in 1877 (MBG). ST CLAIR CO.: Fish Lake, May 5, 1901, *J. H. Kellogg* (MBG). SANGAMON CO.: Mechanicsburg, *G. D. Fuller 3447* (NHS). STARK CO.: Railway embankment, Wady Petra, *V. H. Chase 507, 646.* TAZEWELL CO.: Springy bank in woods, Groveland, *V. H. Chase 3089.* VERMILION CO.: Wet hillside near Oakwood, *G. N. Jones 15256.* WABASH CO.: Hanging Rock, April 25, 1882, *J. Schneck;* Greathouse Creek, July 4, 1880, *J. Schneck;* Mt. Carmel, *J. Schneck 36;* Patton, April 18, 1901 and May 15, 1901, *J. Schneck;* White River, *J. Schneck,* October 1887. WHITESIDE CO.: Morrison, July 17, 1945, *G. H. Boewe* (NHS). WINNEBAGO CO.: Rockford, G. D. Fuller *1011.*

[The report of *E. sylvaticum* by Huett (1898) 166, is based, probably upon a misidentification of *E. arvense.* The known range of *E. sylvaticum* does not include Illinois.]

5. OPHIOGLOSSACEAE Presl — Adder's-Tongue Family

Sporophyte perennial; leaf solitary, consisting of a sterile blade and a simple or compound sporophyll bearing numerous sessile sporangia; annulus none, the sporangia opening at maturity along a transverse slit into two valves; indusium none; spores uniform, yellowish; gametophyte tuberous, mostly hypogean; sperms multiciliate.

1. Sterile blade pinnately divided; venation free; sporangia in a panicle ....1. *Botrychium*
1. Sterile blade simple, entire; venation reticulate; sporangia in two rows in a simple slender spike .....2. *Ophioglossum*

1. BOTRYCHIUM Sw.—Grape Fern

Plants with short erect or ascending rhizomes, fleshy roots, and leaves consisting of a pinnately divided, free-veined, sterile blade, and a stalked sporangium-bearing panicle.

1. Sterile blade stalked, attached near the base of the plant.
2. Leaf-segments incised .....*B. dissectum*
2. Leaf-segments merely crenate or serrulate.
3. Blades thin; segments acutish .....*B. obliquum*
3. Blades thick; segments obtuse .....*B. multifidum*
1. Sterile blade nearly or quite sessile, attached near the middle of the plant ..... *B. virginianum*

BOTRYCHIUM DISSECTUM Spreng. Anleit. Kennt. Gew. 3:172 (1804); Hill (1912a) 36; Weatherby (1922) 9; Clausen (1938) 57; Jones (1945) 34.

Botrychium lunarioides sensu Lapham (1857) 550; Schneck (1876) 576. Non *B.* 342 (1884); Hill (1912a) 36.

Type locality.—Virginia.

Range.—N.S.—Minn.—Mo.—Fla.

Leaves 20-40 cm. long, the sterile blade long-stalked, 5-7 cm. broad, inserted near the base of the plant; segments laciniate; sporophyll 3-4-pinnate, long-stalked. — Cut-leaved Grape Fern.

Specimens examined.—GALLATIN CO.: Equality, *E. J. Palmer 17058* (MBG). KANKAKEE CO.: Kankakee, *R. Schneider*, June 1935. PEORIA CO.: Rich woods, Princeville. October 28, 1898, *V. H. Chase*.

BOTRYCHIUM OBLIQUUM Muhl. ex Willd. Sp. Pl. 5:63 (1810); Hill (1912a) 36; Pepoon (1927) 149; Clausen (1938) 53; Fuller (1943) 91; Jones (1945) 34; Fuller (1946) 52.

Botrychium lunarioides var. *obliquum* (Muhl.) A.Gray, Man. Bot. 635 (1848); Patterson (1876) 54.

Botrychium lunarioides sensu Lapham (1857) 550; Schneck (1876) 576. Non *B. lunarioides* (Michx.) Sw.

Type locality.—Pennsylvania.

Range.—N. S.—Minn.—Man.—La.—Fla.; Jamaica.

Sterile blade 10-50 cm. long, inserted near the base, long-stalked, ternately

pinnatifid; segments acute, serrate-dentate; sporophyll long-stalked, 3-4-pinnate. — Oblique Grape Fern.

Woods, rare.

Specimens examined.—COLES CO.: Without definite locality, *G. D. Fuller 11090* (SM). GALLATIN CO.: Equality, *E. J. Palmer 17053* (MBG). LEE CO.: Moist woods, occasional, Franklin Grove, *G. D. Fuller 7450*. PEORIA CO.: Moist woods, Princeville, *V. H. Chase 987* (PAS). PULASKI CO.: Chestnut grove, Olmstead, August 29, 1916, *W. Trelease*. UNION CO.: State Forest, *G. D. Fuller 956*. WABASH CO.: Woods, Mt. Carmel, September 30, 1880, *J. Schneck*. WILL CO.: Joliet, June 10, 1906, *H. C. Cowles* (SM). WINNEBAGO CO.: Shirland, *G. D. Fuller 10868*.

BOTRYCHIUM MULTIFIDUM (S. G. Gmel.) Rupr. Beitr. Pfl. Russ. Reich. **11**:40(1859); Gleason (1910) 9; Jones (1945) 34.

Osmunda multifida S. G. Gmel. Nov. Comm. Acad. Petrop. **12**:517 (1768).

Botrychium ternatum var *intermedium* D.C.Eaton in A.Gray, Man. Bot. (ed. 6) 694 (1890); Gleason (1910) 146.

Botrychium multifidum subsp. *silaifolium* (Presl) Clausen in Mem. Torr. Club **19**: 27 (1938) ex p. *Non Botrychium silaifolium* Presl.

Type locality.—Siberia.

Range.—Lab.—Minn.—Ill.—Pa.; Eurasia.

Plant 5-20 cm. tall; sterile blade 4-8 cm. wide, the ultimate divisions crowded, ovate, obtuse, 4-6 mm. long; fruiting spike dense, 2-6 cm. long. — Leathery Grape Fern.

Woods, rare, northern Illinois.

This species (designated as *B. ternatum* var. *intermedium*) is indicated on a map prepared by E. W. Graves (1931) 131, as occurring in southern Illinois, but this is based, probably, upon an erroneous record, as this plant has been collected in Illinois only in the northern counties. On page 127 of the same article, Graves says that Millers, Indiana (about the same latitude as Chicago) is "the farthest south for that fern of any record that I have seen."

Specimens examined.—MCHENRY CO.: McHenry, August 24, 1881, *A. B. Seymour*. OGLE CO.: Sandy edge of woods, rare, Camp Lowden, *E. W. Fell 45752*. WINNEBAGO CO.: Sandy woods, rare, Shirland, *E. W. Fell 45387*.

BOTRYCHIUM VIRGINIANUM (L.) Sw. in Schrad. Journ. 1800[2]: 111. (1801); Mead (1846) 122; Lapham (1857) 550; Babcock (1873) 98; Patterson (1876) 54; Schneck (1876) 576; Brendel (1887) 65; Higley & Raddin (1891) 151; Huett (1897) 132; Snare & Hicks (1898) 25; Gleason (1910) 146; Hill (1912a) 36; Thone (1925) 101; Pepoon (1927) 151; Steagall (1927) 115; Stover (1930) 25; Jones (1942) 71; Fuller (1943) 91; Clausen (1938) 98; Jones (1945) 34; Fuller (1946) 52.

Osmunda virginiana L. Sp. Pl. 1064 (1753).

Botrychium virginianum var. *intermedium* Butters in Rhodora **19**:210 (1917).

Type locality.—"Habitat in America."

Range.—Que.—Fla.—Tex.—Colo.—B. C.—Alaska; Eurasia.

Plant 30-60 cm. tall; sterile blade nearly or quite sessile, attached near the middle of the plant, thin, membranous, the segments acute, incised; lateral

veins of the leaf-segments unbranched; epidermal cells with flexuous walls. — Rattlesnake Fern.

Moist woods, common; occurring probably in every county.

Specimens examined.—ADAMS CO.: Woods, Camp Point, June 22, 1877, *A. B. Seymour;* woods, Burton Cove, *R. A. Evers 1149;* woods, Fall Creek Gorge, *Evers & Jones 637.* ALEXANDER CO.: Diswood, September 27, 1931, *Pepoon & Barrett* (NHS). BROWN CO.: Siloam, *R. A. Evers 1688* (NHS). CALHOUN CO.: Hardin, *Pepoon & Barrett 4431* (NHS). CHAMPAIGN CO.: Brownfield Woods near Urbana, *F. C. Gates 2324, 2374, G. N. Jones 13653;* woods, Urbana, June 17, 1880, *Seymour & Butts, G. N. Jones 12229;* woods, Mahomet, May 23, 1900, *H. A. Gleason.* CHRISTIAN CO.: Taylorville, June 4, 1897, *Ruby DeMotte.* CLARK CO.: Woods, Rocky Branch, Dolson, *G. N. Jones 12615;* Fox Ridge State Park, *G. N. Jones 10680;* Embarrass River, *G. N. Jones 15087.* COOK CO.: Rich woods, Calumet, June 8, 1898, *E. J. Hill;* rich woods, Morgan Park, June 12, 1878, *E. J. Hill;* rich woods, frequent, Desplaines, *W. S. Moffatt 1272.* EFFINGHAM CO.: Effingham, *Pepoon & Barrett 5509* (NHS). FAYETTE CO.: Woods near St. Elmo, *Louise Odell 2.* FULTON CO.: Canton, *J. Wolf* (SM). HARDIN CO.: Elizabethtown, *E. J. Palmer 15478.* JACKSON CO.: Wooded hillside, Carbondale, *J. McCree 824;* Murphysboro, *J. McCree 716;* Makanda, July 23, 1917, *L. P. Cranwill.* JERSEY CO.: Pere Marquette State Park, *Fuller & Link 111* (SM). JO DAVIESS CO.: Apple River Canyon State Park, *V. O. Graham 9923* (SM). JOHNSON CO.: Wooded slope, Benson Bluff, *Mary M. Steagall 16;* Tunnel Hill, *E. J. Palmer 15161* (MBG). KANE CO.: Sugar Grove, July 9, 1946, *G. H. Boewe* (NHS). LAKE CO.: Rich moist woods, Lake Bluff, June 21, 1910, *E. J. Hill;* Ravinia, *F. C. Gates 1689.* LA SALLE CO.: Starved Rock, *V. H. Chase 4035* (PAS), *G. N. Jones 15748.* LEE CO.: Franklin Grove, *G. N. Jones 15748, 15829;* Dixon, *G. D. Fuller 7041* (SM). MACON CO.: Decatur, *I. W. Clokey,* May 1896; rich woods, C. H. & D. bridge, *I. W. Clokey 2387.* MACOUPIN CO.: West of Carlinville, June 21, 1946, *G. H. Boewe* (NHS); Carlinville, May 23, 1884, *C. Robertson* (NHS). MARION CO.: Sabin, *Pepoon & Barrett 5080* (NHS). MASSAC CO.: Without definite locality, *A. P. Sharp* in 1880. MCHENRY CO.: Algonquin, June 27, ..., *W. A. Nason.* MENARD CO.: Woods, Petersburg, *G. N. Jones 11661.* MONROE CO.: Valmeyer, *V. H. Chase 4954* (PAS). PEORIA CO.: Peoria, *F. Brendel* (no number or date); rich woods, Princeville, *V. H. Chase 75* (PAS); wooded hillside, Peoria, *F. E. McDonald,* July 1889; deep moist woods, Springdale, *F. E. McDonald,* July 1901; wooded hillside, Mossville, July 6, 1898, *Agnes Chase.* PIATT CO.: Piatt County Forest Preserve, May 21, 1941, *L. R. Tehon* (NHS). POPE CO.: Golconda, *E. J. Palmer 15446* (MBG). ST. CLAIR CO.: French Village, *J. B. S. Norton* in 1898 (MBG). SANGAMON CO.: Rich soil, Springfield, *G. D. Fuller 2131.* SCHUYLER CO.: Wooded bluffs of Sugar Creek, *Evers & Jones 576.* STARK CO.: Woods along Spoon River, *V. H. Chase 1421.* TAZEWELL CO.: Woods, three miles east of Upper Bridge, East Peoria, *V. H. Chase 3553* (PAS). UNION CO.: Woods, Anna, *E. J. Palmer 14854* (MBG), August 13, 1880, *A. B. Seymour.* VERMILION CO.: Near Oakwood, *G. N. Jones 14386;* Stony Creek, June 24, 1880, *Seymour & Butts.* WABASH CO.: Rich woods, Mt. Carmel, *J. Schneck,* June 1889, and May 8, 1900, rich woods, Crayfish Creek, Mt. Carmel, May 30, 1906, *J. Schneck.* WILL CO.: Thicket, Mokena, *Agnes Chase 30.* WINNEBAGO CO.: Pecatonica, June 8, 1945, *E. W. Fell* (SM); Rockford, May 21, 1945, *E. W. Fell* (SM). WOODFORD CO.: Wooded hillside north of Spring Bay, *V. H. Chase 7893* (PAS); Woods, Richland Creek, *G. N. Jones 14280.*

[*Botarychium lanceolatum* sensu Huett (1897) 132, and *B. ternatum* sensu Snare & Hicks (1898) 25, are excluded. The later is probably *B. virginianum.*]

2. OPHIOGLOSSUM L.—Adder's-Tongue

Rhizome erect, with slender roots; sterile blade simple, entire; venation reticulate; bud for the following season enclosed in the base of the stalk;

sporangia in two rows in a simple slender spike; spores yellow.

1. Sterile blades apiculate; spores pitted ..... *O. engelmanni*
1. Sterile blades obtuse; spores reticulate ..... *O. vulgatum*

OPHIOGLOSSUM ENGELMANNI Prantl in Ber. Deutsch. Bot. Ges. **1**:351 (1883); Palmer (1932) 46; Clausen (1938) 139; Deam (1940) 38; Jones (1945) 33.

Type locality.—New Braunfels, Comal Co., Texas. Collected by G. Lindheimer.

Range.—Va.—s. Ohio—Mo.—Ariz.—Fla.; Mexico.

Plants 5-20 cm. tall; sterile blades usually 2-5, oval, apiculate, the principal veins 13 or more, forming broad areolae containing numerous included veinlets.

Hillsides, banks, thickets, rare.

Specimens examined.—HARDIN CO.: Cave-in-Rock, *E. J. Palmer 15469* (MBG). JERSEY CO.: Dry hillside, Pere Marquette State Park, *Fuller & Link 47* (SM).

OPHIOGLOSSUM VULGATUM L. Sp. Pl. 1062 (1753); Patterson (1876) 54; Schneck (1876) 576; Seymour (1882) 65; Snare & Hicks (1898) 25; Hill (1912a) 36; Pepoon (1927) 149; Palmer (1932) 45; Clausen (1938) 126.

Ophioglossum pusillum Raf. in Desv. Journ. Bot. Ser. 2, **4**:273 (1814); Jones (1945) 33.

Ophioglossum vulgatum f. *pseudopodum* Blake in Rhodora **15**:87 (1913).

Ophioglossum vulgatum var. *pseudopodum* (Blake) Farwell in Rep. Mich. Acad. Sci. **18**:84 (1916); Fernald in Rhodora **41**:498 (1939).

Type locality.—"Habitat in Europae pratis sylvaticis."

Range.—Que.—Fla.—Ariz.—Alaska; Mexico; Eurasia; W. Africa.

Plants 10-40 cm. tall; sterile blades usually solitary or sometimes 2, oval, obtuse, the principal veins 7-11, forming narrow areolate containing few included veinlets; spores reticulate.

Meadows, open woods, moist thickets, rare.

Specimens examined.—JACKSON CO.: Carbondale, *E. J. Palmer 14961* (MBG). UNION CO.: Pine Hills, April 24, 1882, *A. B. Seymour.* WABASH CO.: Without locality, *J. Schneck.*

6. HYMENOPHYLLACEAE Gaud.—Filmy Fern Family

Small delicate ferns with filiform rhizomes and filmy translucent leaves circinate in vernation, and usually consisting of a single layer of cells; sporangia sessile on a filiform receptacle, within a tubular or urceolate indusium.

TRICHOMANES BOSCHIANUM Sturm ex Bosch, Nederl. Kruidk. Arch. **52**: 160 (1861); Jones (1945) 34.

Type locality.—Near Moulton, Alabama.

Range.—Ohio—Ala.; Ill.; s. Fla.

Leaves bipinnatifid, 10-20 cm. long; rachis narrowly winged; pinnae ovate, toothed or lobed; receptacle filiform, exserted.

On sandstone near a spring, Jackson Hollow, Pope Co., August 2, 1923, *Mary M. Steagall 37.*

[*Trichomanes petersii* A.Gray in Am. Journ. Sci. II. 15:326 (1853), is said by Broun (1938) to be "reported in Illinois," but no Illinois specimens are available to substantiate the report.]

7. OSMUNDACEAE R.Br. —Royal Fern Family

Large ferns with stout rhizomes, 1-2-pinnate free-veined leaves, and large globose stalked sporangia opening vertically, and arranged in panicles on modified pinnae; annulus none or rudimentary.— Only the following genus in North America:

1. OSMUNDA L.

1. Leaves twice pinnate, some of them fertile at the apex and forming an erect terminal panicle ..... *O. regalis*
1. Leaves once pinnate.
   2. Leaves of two kinds, the fertile and sterile ones separate; sterile leaves longer than the fertile, each pinna with a tuft of tomentum at base ..... *O. cinnamomea*
   2. Sterile and fertile leaves similar, the latter bearing 2-6 pairs of fertile pinnae near the middle; pinnae of the sterile leaves lacking tufts of tomentum at base ..... *O. claytoniana*

OSMUNDA REGALIS L. Sp. Pl. 1065 (1753); Vasey (1861) 143; Babcock (1873) 98; Patterson (1876) 54; Schneck (1876) 576; Brendel (1887) 65; Higley & Raddin (1891) 150; Huett (1897) 132; Hill (1912a) 36; Gates (1912) 353; Thone (1925) 101; Pepoon (1927) 148; Rydberg (1932) 4; Jones (1945) 34.

Osmunda spectabilis Willd. Sp. Pl. 5:98 (1810); Mead (1846) 122; Lapham (1857) 550.

Osmunda regalis var. *spectabilis* (Willd.) A.Gray, Man. Bot. (ed. 2) 600 (1856).

Type locality.—"Habitat in Europa, Virginia."

Range.—Newf.—Sask.—Tex.—Fla.; Bermuda; West Indies; Mexico; S. Am.; Europe.

Leaves tufted, bipinnate, 60-200 cm. long, some of them fertile at the apex and forming an erect terminal panicle; sterile pinnules elliptical, serrulate, widely separate. — Royal Fern.

Swampy ground or in wet woods, local.

Specimens examined.—CASS CO.: Swamps, Beardstown, *F. E. McDonald*, June 1901. COOK CO.: Thornton, *G. D. Fuller 1204* (SM). Damp prairies, Evanston, May 30, 1889, *L. N. Johnson*. GRUNDY CO.: Coal City, *V. H. Chase 6115* (PAS). KANKAKEE CO.: Wet ground, Waldron, July 10, 1873, *E. J. Hill;* Bonfield, *G. N. Jones 15892;* edge of swamp, Saint Anne, *G. N. Jones 11447, 11507*. LAKE CO.: In bog, Cedar Lake, *Mary M. Steagall 27;* Beach, *F. C. Gates 2765*. LA SALLE CO.: Starved Rock State Park, May 27, 1939, *F. G. Werner* (NHS). MASON CO.: Swamps, without definite locality, *E. Hall* in 1861. OGLE CO.: Oregon, June 22, 1885, *M. B. Waite*. PEORIA CO.: Peoria, *F. Brendel* in 1860. TAZEWELL CO.: Near Upper Ferry, *F. Brendel* (PAS). WILL CO.: Braidwood, *W. C. Dodge*, May 1878.

OSMUNDA CINNAMOMEA L. Sp. Pl. 1066 (1753); Babcock (1873) 98; Patterson (1876) 54; Brendel (1887) 89; Higley & Raddin (1891) 151; Huett (1898) 132; Hill (1912a) 36; Thone (1925) 101; Pepoon (1927) 149; Steagall (1927) 115; Jones (1945) 33.

Type locality.—Maryland.

Range.—Newf.—Fla.—Mexico—Man.; West Indies; Brazil; Eurasia.

Leaves of two kinds, the fertile and sterile ones separate; sterile leaves 1-pinnate, longer than the fertile; each pinna with a tuft of tomentum at the base. — Cinnamon Fern.

Swampy ground, chiefly in the northern part of the state.

Specimens examined.—COOK CO.: Edgebrook Chicago, *John Higgins* (no date or number); Thornton, *G. D. Fuller 1128* (SM). KANKAKEE CO.: Thicket, Saint Anne, *C. N. Jones 11416;* wet ground, Kankakee, July 22, 1874, *E. J. Hill.* LAKE CO.: Swamp, Volo, *G. N. Jones 15129.* LA SALLE CO.: Starved Rock State Park, May 27, 1939, *F. G. Werner* (NHS). OGLE CO.: Foot of sandstone cliff, Grand Detour, *Mary M. Steagall 25;* Castle Rock, September 5, 1945, *E. W. Fell* (SM). WILL CO.: Braidwood, *W. C. Dodge*, May 1878.

OSMUNDA CLAYTONIANA L. Sp. Pl. 1066 (1753); Lapham (1857) 550; Forbes (1870) 318; Babcock (1873) 98; Patterson (1874) 18, (1876) 54; Schneck (1876) 576; Brendel (1887) 65; Higley & Raddin (1891) 150; Huett (1897) 132; Snare & Hicks (1898) 25; Hill (1912a) 36; Thone (1925) 101; Gates (1926) 226; Pepoon (1927) 148; Stover (1930) 26; Jones (1945) 34; Fuller (1946) 52.

Osmunda interrupta Michx. Fl. Bor. Am. **2**:273 (1803); Mead (1846) 122.

Type locality.—Virginia.

Range.—Newf.—N.C.—Mo.—Nebr.—Minn.

Leaves pinnate, 30-120 cm. long, tomentose when young, some of the larger ones with 2-6 of the middle pinnae fertile; sterile pinnae lacking tufts of tomentum. — Interrupted Fern.

Moist ground in woods, local.

Specimens examined.—BUREAU CO.: Rich woods west of Putnam, *V. H. Chase 4021* (PAS). CHRISTIAN CO.: Woods, Taylorville, May 6, 1899, *W. E. Andrews.* CLARK CO.: Rocky Branch, *H. S. Pepoon 5356* (NHS). FULTON CO.: Canton, *J. Wolf* (SM). JERSEY CO.: Pere Marquette State Park, *Fuller & Link 117.* JO DAVIESS CO.: Rush Tp., *Pepoon & Barrett 4118* (NHS). KANKAKEE CO.: Wet banks, Kankakee, May 23, 1874, *E. J. Hill;* moist thicket, Saint Anne, *G. N. Jones 11401, 11428.* LA SALLE CO.: Starved Rock, *F. Thone 131.* LEE CO.: Amboy, *V. H. Chase 4350* (PAS). MCHENRY CO.: Ringwood, May 31, 1858, *G. Vasey.* OGLE CO.: Oregon, June 27, 1885, *M. B. Waite;* Grand Detour, *Mary M. Steagall 26.* PEORIA CO.: Wooded hills, Peoria, *F. E. McDonald*, May 1889; low woods, Jubilee, *Agnes Chase*, August 1892; dry woods above Rocky Glen, Peoria, rare, *F. E. McDonald*, June 1891; Peoria, *F. Brendel* (no number or date). STARK CO.: Rich woods, Spoon River, July 20, 1892, *V. H. & Agnes Chase.* UNION CO.: Cobden, July 31, 1886, *F. S. Earle.* WABASH CO.: Bluff on Crayfish Creek, May 23, 1880, *J. Schneck.* WILL CO.: Braidwood, *W. C. Dodge*, May 1878.

8. POLYPODIACEAE R. Br.—Fern Family

Sporophyte perennial; leaves usually large, petiolate, compound or simple, coiled in vernation; veins free, or rarely reticulate; spores uniform, in numerous

stalked sporangia, each with a vertical annulus; sporangia in sori on the backs or margins of the leaves.

1. Sporangia enclosed in globose or necklace-like brownish portions of the contracted and modified fertile leaves; fertile and sterile leaves dissimilar.
   2. Sterile leaves 1-pinnatifid, the veins reticulate; fertile leaves 2-pinnate; rhizome horizontal, the leaves therefore solitary ..... 1. *Onoclea*
   2. Sterile leaves 2-pinnatifid, the veins free; fertile leaves 1-pinnate; rhizome short, erect, the leaves therefore tufted ..... 2. *Pteretis*
1. Sporangia on the margin or back of ordinary foliar or modified leaves.
   3. Indusium inferior or partly so (often evanescent).
      4. Sori marginal, in minute cup-like inferior indusia at the ends of the veins; leaves bipinnate, delicate, fragrant, sparsely glandular-pubescent beneath ..... 5. *Dennstaedtia*
      4. Sori dorsal.
         5. Indusium wholly inferior, roundish at first, soon splitting ..... 4. *Woodsia*
         5. Indusium partly inferior, delicate, hood-like, attached by its base at one side ..... 3. *Cystopteris*
   3. Indusium superior or none.
      6. Sori dorsal, i.e., on the back of the leaves away from the margin, or if apparently near the margin not covered by the revolute edge of the leaf-segments.
         7. Sori roundish.
            8. Stipes not jointed to the rhizome; indusium (if present) conspicuous, but often soon deciduous.
               9. Indusium orbicular, peltate; leaves (in our species) 1-pinnate, the stipe and rachis scaly, the pinnules spinulose-serrate, auriculate at the base of the upper margin ..... 6. *Polystichum*
               9. Indusium (lacking in some species) reniform, attached at its sinus; leaves 1-3-pinnately compound ..... 7. *Dryopteris*
            8. Stipes jointed to the rhizome; blades pinnately lobed; indusium none..... ..... 8. *Polypodium*
         7. Sori elongated, oval to oblong or linear, straight or curved, two or more times as long as wide.
            10. Leaves simple, entire, 5-30 cm. long, lanceolate, tapering from a truncate or cordate or even hastate base, rooting at the tip and thus giving rise to new plants; veins forking and anastomosing ..... 9. *Camptosorus*
            10. Leaves pinnate or pinnatifid.
               11. Leaves evergreen, coriaceous, small (5-40 cm. long); stipes firm, slender, wiry, brown or black ..... 10. *Asplenium*
               11. Leaves not evergreen, herbaceous; stipes soft, stoutish, stramineous (when dry).
                  12. Sori in chain-like rows parallel to the midveins; veins united to form a series of narrow areolae along the midrib, elsewhere free ..... 12. *Woodwardia*
                  12. Sori and venation otherwise ..... 11. *Athyrium*
      6. Sori marginal, i.e., borne at the edges of the lobes or segments of the leaves, either in definite sori or in a continuous line and covered by the revolute leaf-margin.
         13. Leaves pedate, the stipe forked at the summit, dark brown or black, smooth, glossy; pinnules flabellate; sori several, distinct ..... 15. *Adiantum*
         13. Leaves not pedate, the stipe simple; sori apparently continuous along the margin of the pinnules.

14. Sori borne near the tips of separate veins; rhizomes scaly; chiefly small, rupestral ferns.
15. Leaves delicate, strongly dimorphic; stipe straw-colored or pale brown ..... 13. *Cryptogramma*
15. Leaves firm, nearly or quite uniform; stipes dark brown or blackish..
16. Leaf-blades glabrous ..... 14. *Pellaea*
16. Leaf-blades pubescent ..... 16. *Cheilanthes*
14. Sori borne on a heavy marginal vein extending around the lobes; leaves coarse, ternate; rhizomes horizontal, black, not scaly ..... 17. *Pteridium*

1. ONOCLEA L.

Leaves dimorphous, from a horizontal rhizome, the sterile ones foliaceous, net-veined, the fertile bipinnate, with contracted pod-like subdivisions; sori roundish.

ONOCLEA SENSIBILIS L. Sp. Pl. 1062 (1753); Mead (1846) 122; Lapham (1857) 550; French (1870) 383; Babcock (1873) 98; Patterson (1876) 54; Schneck (1876) 575; Brendel (1887) 65; Higley & Raddin (1891) 150; Huett (1897) 132; Hill (1912a) 40; Sherff (1913) 593; Gates (1922) 165; Thone (1925) 101; Steagall (1927) 115; Pepoon (1927) 147; Stover (1930) 25; Fuller (1943) 91; Jones (1945) 36; Fuller (1946) 52.

Type locality.—Virginia.

Range.—Newf.—Fla.—Tex.—S.D.—Sask.

Sterile leaves pinnatifid, 30-100 cm. long, the segments lanceolate or elliptical, entire to sinuate-pinnatifid, the rachis winged; fertile leaves bipinnate, the pinnules contracted into pod-like divisions. — Sensitive Fern. Bead Fern. Moist woods, or edges of meadows, common.

Specimens examined.—ADAMS CO.: Camp Point, July 31, 1878, *A. B. Seymour.* ALEXANDER CO.: Diswood, *Pepoon & Barrett 684* (NHS). BROWN CO.: Siloam, *R. A. Evers 1656* (NHS). CHAMPAIGN CO.: Urbana, September 13, 1879, *A. B. Seymour;* woods, Urbana, August 8, 1888, *G. P. Clinton.* COOK CO.: Woods, Lombard, *W. S. Moffatt 879;* damp sandy thicket, Edgewater, Chicago, *Agnes Chase,* July 1896, and May 1897; thicket, Rogers Park, August 27, 1896, *Agnes Chase.* HENDERSON CO.: Oquawka, *H. N. Patterson,* September 1881. JACKSON CO.: Carbondale, *E. J. Palmer 16494;* gravelly soil, common, Makanda, July 22, 1917, *L. P. Cranwill;* in ravine, Big Hill, *Mary M. Steagall 23;* Fountain Bluff, *Bauer 2358.* JERSEY CO.: Pere Marquette State Park, *Fuller & Link 121* (SM). KANKAKEE CO.: Moist thicket, Saint Anne, *G. N. Jones 11407, 11521;* wet ground, Kankakee, June 7, 1873, *E. J. Hill.* KNOX CO.: Moist thicket, Williamsfield, *V. H. Chase 1629.* LAKE CO.: Bog, Volo, *G. N. Jones 15161;* Beach, *F. C. Gates 3124.* LA SALLE CO.: Starved Rock, *F. Thone 27.* MCDONOUGH CO.: Macomb, *Pepoon & Barrett 4270* (NHS). MENARD CO.: Wet places, without definite locality, *E. Hall* in 1861. MORGAN CO.: Without definite locality, *G. M. Savage,* no number or date. OGLE CO.: Oregon, *E. Keithley 119* (SM). PEORIA CO.: Peoria, *Alice J. Hardin* (no number or date), *F. Brendel* (no number or date). PULASKI CO.: Mounds, *E. J. Palmer 14817* (MBG). RICHLAND CO.: Parkersburg, *E. J. Palmer 15658* (MBG). SANGAMON CO.: Springfield, *G. N. Jones 11647.* TAZEWELL CO.: Bottom woods, without definite locality, *F. E. McDonald,* May 1889. UNION CO.: Ware, *Pepoon & Mohr 316* (NHS). VERMILION CO.: Without definite locality, June 24, 1880, *Seymour & Butts.* WABASH CO.: Bompas Bottoms, *H. Shearer 63;* Mt. Carmel, *J. Schneck,* September 1897. WINNEBAGO CO.: Rockford, *M. S. Bebb* in 1871: Pecatonica, June 8, 1945, *E. W. Fell* (SM).

2. PTERETIS Raf.

Leaves coarse, tufted from a short erect or ascending rhizome, dimorphous, the sterile herbaceous, bipinnatifid, free-veined, the fertile 1-pinnate, rigid, erect, with contracted, pod-like pinnae containing the sporangia.

PTERETIS STRUTHIOPTERIS (L.) Nieuwl. in Am. Midl. Nat. **3**:197 (1914).

Osmunda struthiopteris L. Sp. Pl. 1066 (1753).

Struthiopteris filicastrum All. Fl. Pedem. **2**:283 (1785).

Onoclea struthiopteris (L.) Hoffm. Deutsch. Fl. **2**:11 (1795); Huett (1897) 132; Hill (1912a) 40; Thone (1925) 101; Pepoon (1927) 147.

Onoclea nodulosa Michx. Fl. Bor. Am. **2**:272 (1803).

Struthiopteris germanica Willd. Enum. 1071 (1809); Mead (1846) 122; Brendel (1859) 585; Vasey (1861) 143; Patterson (1874) 18, (1876) 54; Brendel (1887) 65.

Struthiopteris pensylvanica Willd. Sp. Pl. **5**:289 (1810).

Matteuccia struthiopteris (L.) Todaro, Giorn. Sci. Nat. Palermo **1**:235 (1866); Maxon (1913) 11; Gates (1926) 226.

Pteretis nodulosa (Michx.) Nieuwl. in Am. Midl. Nat. **4**:334 (1916); Jones (1945) 36; Fuller (1946) 52.

Pteretis pensylvanica (Willd.) Fern., in Rhodora **47**:123 (1945).

Type locality.—"Habitat in Suecia, Helvetia, Russia, Norvegica."

Range.—Newf.—Va.—S.D.—B.C.—Alaska; Eurasia.

Rhizome stout, bearing a circle of sterile leaves with fertile ones in the center; sterile leaves 0.5-3 m. long, the pinnae numerous, linear-lanceolate, pinnatifid, free-veined; fertile leaves shorter, with rigid, upcurved, pod-like pinnae. — Ostrich Fern.

Moist woods, not common in Illinois.

This many-named species is here treated as *Pteretis struthiopteris* on the theory that Eurasian and American plants are conspecific, a view commonly held by almost all botanists during the nineteenth century, and which was scarcely questioned until in 1915 Fernald[1] argued for the specific distinctness of American plants. Fernald said: "Departing from the European *Matteuccia struthiopteris* in nearly all details and quite isolated from it, the North American plant seems to be, as treated by the earlier students of our flora, a distinct American species which should be called *Matteuccia nodulosa*." Nevertheless, it must be admitted that specimens of Eurasian and American plants of this species appear to be morphologically indistinguishable in all essential respects, nor is the American population "quite isolated," but has as nearly a continuous distribution from Newfoundland to Virginia and westward to South Dakota and British Columbia, and northward through Alaska to Asia and western Europe, as its ecological requirements permit. Supposed differences of the fertile pinnae, color of scales at base of stipe, texture, size, and shape of leaves, and direction of pinnae, are, with the possible exception of the color of the scales (a character impossible to ascertain on the majority of herbarium specimens), utterly unreliable taxonomic characters, and until better ones can

[1] Rhodora **17**:164 (1915).

be brought forward to support the theory of specific distinctness of American from Eurasian plants, the only scientifically defensible course to follow is to treat them as conspecific under the name *Pteretis struthiopteris*.

In 1941, E. Hultén,[2] in his Flora of Alaska and Yukon, concluded that: "No doubt the population of the species in America is somewhat different in these respects from the European, but I cannot see that the difference is so large that it justifies a specific separation. A wide variation in the characters concerned is also found in European specimens." Hultén uses the name *Struthiopteris filicastrum* All., probably on the strength of a proposal by Mansfeld that Struthiopteris be placed on the list of Nomina Conservanda, but since that has not yet been done I am retaining Pteretis as the name of the genus.

Specimens examined.—CARROLL CO.: Wooded ravine, Palisades States Park, Savanna, *G. N. Jones 17296*. HANCOCK CO.: Carthage, *Kirchherr & Fuller 5* (SM). HENDERSON CO.: Oquawka, *H. N. Patterson* in 1874. HENRY CO.: Without definite locality, May 15, 1938, *R. J. Dobbs* (NHS). JO DAVIESS CO.: Rocky banks, Apple River, *H. S. Pepoon & W. S. Moffatt 240*. LA SALLE CO.: Moist woods along the Illinois River, Starved Rock, July 18, 1901, *E. J. Hill;* Starved Rock, *Mary M. Steagall 24*, rich damp woods, Starved Rock, *Agnes Chase 1588;* Starved Rock, *F. Thone 23*. OGLE CO.: Castle Rock, October 27, 1945, *E. W. Fell* (SM). PEORIA CO.: Peoria, *F. Brendel* (no number or date).

3. CYSTOPTERIS Bernh.—Bladder Fern

Small ferns with pinnately compound thin leaves; sori roundish, dorsal upon the veins; indusium hood-like, attached by its base at one side, soon becoming torn and pushed aside by the growing sporangia, hence not conspicuous.

1. Leaves broadly lanceolate, acute, 20-40 cm. long, the basal pair of pinnae usually slightly shortened; bulblets none ..... *C. fragilis*

1. Leaves narrowly lanceolate, 30-120 cm. long when mature; axils of some of the upper pinnae usually bearing small bulblets on the lower surface; basal pair of pinnae the largest ..... *C. bulbifera*

CYSTOPTERIS FRAGILIS (L.) Bernh. in Schrad. Journ. Bot. 1[2]:27 (1806); Lapham (1857) 549; Forbes (1870) 318; French (1870) 383; Babcock (1873) 98; Patterson (1874) 18, (1876) 54; Schneck (1876) 575; Brendel (1887) 65; Higley & Raddin (1891) 150; Huett (1897) 132; Hill (1912a) 40; Thone (1925) 101; Steagall (1927) 115; Pepoon (1927) 147; Stover (1930) 25; Weatherby (1935) 373; Jones (1942) 71; Fuller (1943) 91; Jones (1945) 36.

Polypodium fragile L. Sp. Pl. 1091 (1753).

Filix fragilis (L.) Gilib. Exerc. Phyt. 558 (1792); Gates (1922) 165.

Aspidium fragile (L.) Sw. Journ. Bot. Schrad. 1800[2]: 40 (1801); Mead (1846) 121.

Type locality.—European.

Range.—Greenl.—Ga.—Tex.—Calif.—Alaska; Trop. Am.; Eurasia.

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2 Lunds Universitets Årsskr. **37**:19 (1941).

Rhizome horizontal; leaves tufted, glabrous, delicate, oblong-lanceolate in outline, acuminate, 1-2-pinnately compound, 20-40 cm. long; stipes pale brown, brittle; pinnae lanceolate. — Brittle Fern.

Moist soil in woods, common; the most abundant fern in Illinois.

All Illinois material examined belongs to var. *protrusa* Weatherby (1935) 373, which differs from "typical" *C. fragilis* chiefly in its somewhat different leaves, its longer rhizome, and usually woodland habitat. Further study may show it to be specifically separable from *C. fragilis*. Mr. Weatherby also cites a specimen (*Greenman, Lansing & Dixon 168*) of var. *mackayii* Laws. (Fern Fl. of Canada 233. 1889) from Starved Rock.

Specimens examined.—ADAMS CO.: Woods near Coe Springs, *Evers & Jones 509*. CALHOUN CO.: Kampsville, *L. M. Turner 137, 328* (FM). CHAMPAIGN CO.: Brownfield Woods near Urbana, *G. N. Jones 16763;* University [Trelease] Woods near Urbana, *G. N. Jones 15624;* Urbana, July 7, 1886, *M. B. Waite;* woods, Urbana, June 17, 1880, *Seymour & Butts;* rich woods, without definite locality, *F. C. Gates 2388*. CLARK CO.: Woods along Rocky Branch near Dolson, *G. N. Jones 12616*. COLES CO.: Woods, Fox Ridge State Park, *G. N. Jones 16693;* wooded banks, Embarrass River, *G. N. Jones 11161, 13321*. COOK CO.: Damp woods, River Grove, July 14, 1897, *E. J. Hill, Agnes Chase 289;* shaded banks, Wildwood, Chicago, October 24, 1898, *E. J. Hill;* moist bank, Calumet, *Agnes Chase 1014;* woods, Evanston, June 5, 1889, *L. N. Johnson;* Morgan Park Ridge, *R. A. Dixon & L. Cornelia Gage 639* (FM); Chicago, *R. Bebb 928* (FM); limestone cliff, Lemont, June 29, 1898, *E. J. Hill;* moist shaded clefts in limestone rocks, Lemont, June 13, 1905, *E. J. Hill;* shaded limestone ledge of ravine, Lemont, June 29, 1899, *E. J. Hill;* calcareous cliff, Lemont, June 23, 1904, *E. J. Hill*. EFFINGHAM CO.: Effingham, *Pepoon & Barrett 5508* (NHS). FAYETTE CO.: Ramsey, *Louise Odell 3*. FULTON CO.: Thompson Lake, *F. C. Gates 3903;* Sepo, *F. C. Gates 3698*. HARDIN CO.: Elizabethtown, April 28, 1928, *C. J. Telford* (NHS). HENRY CO.: Geneseo, June 14, 1943, *R. J. Dobbs* (NHS). JACKSON CO.: Moist rock crevices, Giant City, *Mary M. Steagall 22;* rich woods, Grand Tower, May 5, 1902, *H. A. Gleason;* rocky creek bed, near Makanda, *G. N. Jones 11924*. JERSEY CO.: Pere Marquette State Park, *G. D. Fuller 110* (NHS). JOHNSON CO.: Rich rocky soil, Tunnel Hill, May 26, 1902, *J. Schneck*. KANE CO.: Elgin, *G. Vasey*, no date or number (PAS). KANKAKEE CO.: Rich woods, Kankakee, *E. J. Hill* in 1873. LAKE CO.: Moist mossy bank of ravine, Lake Bluff, June 6, 1908, *E. J. Hill*. LA SALLE CO.: Starved Rock, *Greenman, Lansing & Dixon 168* (FM); Ottawa. June 3, 1918, *Ana King* (FM). MACOUPIN CO.: Enos, June 21, 1946, *G. H. Boewe* (NHS). MCHENRY CO.: Algonquin, August 14, 1879, *W. A. Nason*. MARION CO.: Sandoval, June 6, 1944, *G. H. Boewe* (NHS). MENARD CO.: Athens, *E. Hall* in 1861 (FM). OGLE CO.: Shaded rocks, Oregon, June 25, 1882, *M. B. Waite;* Moist woods, common, White Pines Forest State Park, *Alice L. Hills 3554*. PEORIA CO.: Wooded ravine, Horseshoe Bottoms, Peoria, *V. H. Chase 3932;* Peoria, *F. Brendel* (no number or date); rich woods, Princeville, *V. H. Chase 39*, and May 28, 1896; rich woods, Mossville, *Agnes Chase 895*. PIKE CO.: Kinderhook, June 28, 1944, *G. H. Boewe* (NHS); Florence, July 1, 1943, *G. H. Boewe* (NHS). SANGAMON CO.: Fancy Creek, *G. D. Fuller 3738* (SM); STARK CO.: wooded hillside, Wady Petra, *V. H. Chase 62*. UNION CO.: *Cobden*, July 25, 1886, *F. S. Earle*, August 18, 1880, *A. B. Seymour*. VERMILION CO.: Moist woods, Kickapoo State Park, *R. A. Evers 466;* near Oakwood, *G. N. Jones 13519;* Stony Creek, June 24, 1880, *Seymour & Butts*. WABASH CO.: Hanging Rock, July 27, 1880, *J. Schneck*. WHITE CO.: Enfield, *Pepoon & Barrett 5164* (NHS). WILL CO.: *Mokena*, June 22, 1897, *E. J. Hill;* rock bank, Sugar Run, Joliet, July 20, 1908, *E. J. Hill;* Joliet, *H. C. Skeels 349* (FM).

CYSTOPTERIS BULBIFERA (L.) Bernh. in Schrad. Journ. Bot. 1^2:26 (1806); Vasey (1860) 119, (1861) 143; Patterson (1874) 18, (1876) 54; Schneck (1876) 575; Brendel (1887) 65; Higley & Raddin (1891) 150;

Huett (1897) 132; Deam (1910) 365; Hill (1912a) 40; Thone (1925) 101; Steagall (1927) 115; Pepoon (1927) 147; Jones (1945) 36; Fuller (1946) 52.

Polypodium bulbiferum L. Sp. Pl. 1091 (1753).

Filix bulbifera (L.) Underw. Native Ferns (ed. 6) 119. 1900; Pepoon (1909) 36.

Type locality.—"Habitat in Canada."

Range.—Newf.—N. S.—Man.—Iowa—Ark.—Ga.; Utah—Ariz.

Rhizome short; leaves lanceolate, acuminate, minutely glandular, 30-60 cm. long, 2-pinnate; rachis and pinnae often bearing small bulblets underneath; basal pair of pinnae the largest.

On moist cliffs in shaded ravines, not uncommon.

Specimens examined.—ADAMS CO.: Among rocks in bank of small intermittent stream, Burton, *R. A. Evers 1131;* rocks, Fall Creek, June 28, 1877, *A. B. Seymour;* on rocky cliffs, Fall Creek Gorge, *Evers & Jones 668.* CARROLL CO.: Mt. Carroll, *G. D. Fuller 1736* (FM); wooded hillside, Savanna, *Agnes Chase 1876.* COOK CO.: Lemont, June 13, 1899, *E. J. Hill.* HENDERSON CO.: Rocky hillside, Oquawka, *H. N. Patterson* in 1879. JACKSON CO.: Without locality, July 12, 1871, *G. H. French* (FM). JERSEY CO.: Pere Marquette State Park, *Fuller & Link 302* (SM). JO DAVIESS CO.: Apple River Canyon State Park, *V. H. Chase 5369, 5371, 6754, 6761, 6780* (PAS), *G. N. Jones 15853;* rocky ledges of Apple River, *Pepoon & Moffatt 176;* Warren, *H. S. Pepoon,* July 1891 (FM); Galena, *O. E. Lansing 518* (FM). JOHNSON CO.: Benson Bluff, *Mary M. Steagall 21.* KANKAKEE CO.: Ravines, Kankakee, June 13, 1871, *E. J. Hill;* Rock Creek, *G. D. Fuller 9008* (SM). LA SALLE CO.: Utica, June 12, 1877, *E. W. Andrews;* Deer Park, August 5, 1883, *F. Brendel;* Starved Rock, *F. Thone 26.* LEE CO.: Franklin Creek, *G. D. Fuller 8018* (SM). LIVINGSTON CO.: Rowe, *G. D. Fuller 8524* (SM). OGLE CO.: Rocky bank of Rock River, August 26, 1891, *Mrs. C. M. Winston;* White Pines Forest State Park, June 25, 1945, *E. W. Fell* (SM). PEORIA CO.: Peoria, *F. Brendel* (no date or number), rocky defiles, rare, *F. E. McDonald,* July 1890. ST. CLAIR CO.: Without locality, July 2, 1878, *H. Eggert* (MBG). STEPHENSON CO.: Rock City, November 2, 1945, *E. W. Fell* (SM). TAZEWELL CO.: Without locality, *J. T. Stewart* in 1863 (FM). UNION CO.: Among rocks, Fountain Bluff, *L. P. Cranwill* (no date or number), *V. H. Chase 6631* (PAS). WABASH CO.: Hanging Rock, October 20, 1882, *J. Schneck.* WILL CO.: Limestone ledge, Lockport, June 13, 1899, *E. J. Hill,* moist ravine, June 14, 1899, *Agnes Chase,* July 20, 1860, *F. Scammon* (FM). WINNEBAGO CO.: Rockford, *G. D. Fuller 10171* (SM).

4. WOODSIA R.Br.

1. Leaves 20-50 cm. long, mniutely glandular; stipe not jointed ..... *W. obtusa*
1. Leaves 5-15 cm. long, rusty-chaffy beneath; stipe jointed a short distance above its base ..... *W. ilvensis*

WOODSIA OBTUSA (Spreng.) Torr. Cat. Pl. in Geol. Rep. New York 195 (1840); Vasey (1860) 119, (1861) 143; French (1870) 383; Patterson (1876) 54; Schneck (1876) 575; Brendel (1887) 89; Huett (1897) 132; Snare & Hicks (1898) 25; Gleason (1910) 146; Hill (1912a) 40; Steagall (1927) 115; Pepoon (1927) 147; Ries (1939) 90; Jones (1945) 36; Fuller (1946) 52.

Polypodium obtusum Spreng. Anleit. Kennt. Gew. **3**:92 (1804).

Woodsia perriniana (Spreng.) Hook. & Grev. Ic. Fil. pl. 68 (1828); Engelmann (1844) 104.

Type locality.—Lancaster County, Pennsylvania.

Range.—N. S.—N. H.—Ga.—Ariz.—Tex.—Minn.—B. C.

Leaves lanceolate, minutely glandular, 15-30 cm. long; pinnae remote, ovate, 2.5-5 cm. long, pinnately parted, segments oblong, obtuse, crenate, the lower pinnatifid; indusium splitting into several spreading jagged lobes. — Cliff Fern.

Cliffs and wooded banks, not common.

Specimens examined.—ADAMS CO.: Burton Creek, *G. D. Fuller 7800* (SM). BOONE CO.: Sandy bluff, rare, Belvidere, *E. W. Fell 45740*. CARROLL CO.: Palisades State Park, June 17, 1945, *E. W. Fell*. CASS CO.: Sandy ravine near Chandlerville, *G. D. Fuller 12537*. CLARK CO.: Wooded bank along Rocky Branch, *G. N. Jones 16694*. COOK CO.: Lemont, *E. J. Hill* in 1904 and 1906. FULTON CO.: *J. Wolf* (SM). HANCOCK CO.: Pulaski, June 27, 1878, *A. B. Seymour*. JACKSON CO.: Makanda, *G. Vasey* (no number or date). JERSEY CO.: Pere Marquette State Park, *Fuller & Link* (SM). Fountain Bluff, *V. H. Chase 6240, 6665* (PAS). JO DAVIESS CO.: Limestone rocks, Warren, *H. S. Pepoon*, July 1908. JOHNSON CO.: Tunnel Hill, *E. J. Palmer 16126* (MBG). KANKAKEE CO.: June 28, 1933, *R. Schneider;* crevices of limestone cliffs, Rockville, *G. N. Jones 13529*. LA SALLE CO.: Starved Rock, *G. D. Fuller 1700* (SM). OGLE CO.: Sandstone cliffs, Oregon, July 8, 1905, *E. J. Hill;* on soil of sandstone cliff, mostly in shade, July 8, 1905, *E. J. Hill;* sand rocks, Oregon, August 30, 1884, *M. B. Waite;* rocky bank, White Pines Forest State Park, *G. D. Fuller 4816;* wooded hillside, occasional, White Pines Forest State Park, *E. W. Fell 45740*. PEORIA CO.: Peoria, *V. H. Chase 3933, 4485* (PAS). POPE CO.: Golconda, *E. J. Palmer 15368* (MBG); Deep soil in open woods, Jackson Hollow, *Mary M. Steagall 39*. PULASKI CO.: Mounds, *E. J. Palmer 14884* (MBG); Chestnut grove, Olmstead, August 29, 1916, *W. Trelease*. ST. CLAIR CO.: Bluff Lake, September 3, 1878, *H. Eggert* (MBG). SALINE CO.: Swartz Hill, September 12, 1931, *Pepoon & Foster* (NHS); Rudement, *J. Schopf* in 1931 (NHS). UNION CO.: Cobden, July 25, 1886, *F. S. Earle;* without definite locality, *F. Brendel* in 1860. WABASH CO.: Woods, Hanging Rock, July 27, 1880, *J. Schneck*. WOODFORD CO.: Spring Bay, *V. H. Chase 4550, 6083* (PAS).

WOODSIA ILVENSIS (L.) R.Br. Prodr. Fl. Nov. Holl. 158 (1810); Patterson (1876) 54; Brendel (1887) 89; Huett (1897) 132; Hill (1912a) 40; Thone (1925) 101; Jones (1945) 36.

Acrostichum ilvense L. Sp. Pl. 1071 (1753).

Type locality.—Europe.

Range.—Greenl.—Me.—N. C.—Iowa—Minn.—Alaska. Eurasia.

Leaves pinnate, rusty-chaffy beneath, smooth above; stipes jointed some distance above the base; indusium split into slender filiform segments which are curled over the sporangia. — Rusty Woodsia.

Cliffs, rare.

Specimens examined.—OGLE CO.: Sand rock, Oregon, September 8, 1885, *M. B. Waite;* Castle Rock, *Pepoon & Barrett 5015* (NHS).

5. DENNSTAEDTIA Bernh.

Ferns with pinnatifid leaves arising from slender rhizomes; sori small, globose, marginal or submarginal; sporangia borne in a globose receptacle, enclosed in the inferior 2-valved, cup-like indusium.

DENNSTAEDTIA PUNCTILOBULA (Michx.) Moore, Ind. Fil. 307 (1857); Conard (1908); Jones (1945) 36.

Nephrodium punctilobulum Michx. Fl. Bor. Am. **2**:268 (1803).

Dicksonia punctilobula (Michx.) A. Gray, Man. Bot. 628 (1848); Lapham (1857) 549; Patterson (1876) 54; Schneck (1887) 575; Hill (1910) 70, (1912a) 40.

Dicksonia pilosiuscula Willd. Enum. Pl. Hort. Berol. 1076 (1809); Mead (1846) 121; Snare & Hicks (1898) 25.

Type locality.—"Hab. in Canada."

Range.—N. S.—Ind.—Ark.—Ga.

Leaves minutely glandular, acuminate, 30-90 cm. long, thin, pale green, mostly bipinnate; sori minute, borne on a recurved tooth, usually one at the upper margin of each lobe. — Hay-scented Fern.

Sandstone cliffs in wooded ravines, very rare in Illinois. Wabash Co., *J. Schneck* (fide Patterson).

6. POLYSTICHUM Roth

Leaves chiefly coriaceous, often evergreen, tufted at the end of a stout woody erect or ascending rhizome; stipes scaly; pinnae usually auriculate at the base, spinulose-serrate; sori dorsal, round; indusium superior, orbicular, peltate.

POLYSTICHUM ACROSTICHOIDES (Michx.) Schott, Gen. Fil. pl. 9 (1834); Hill (1912a) 39; Thone (1925) 101; Gates (1926) 226; Steagall (1927) 115; Pepoon (1927) 145; Stover (1930) 26; Fuller (1943) 91; Jones (1945) 36; Fuller (1946) 52.

Nephrodium acrostichoides Michx. Fl. Bor. Am. **2**:267 (1803).

Aspidium acrostichoides (Michx.) Sw. Syn. Fil. 44 (1806); Mead (1846) 121; Lapham (1857) 549; French (1870) 383; Patterson (1874) 18, (1876) 54; Schneck (1876) 575; Brendel (1887) 65; Huett (1897) 132; Higley & Raddin (1891) 150.

Aspidium schweinitzii Beck, Bot. U.S. 449 (1833).

Polystichum acrostichoides var. *incisum* A.Gray, Man. Bot. 632 (1848).

Polystichum acrostichoides var. *schweinitzii* (Beck) Small, Bull. Torr. Club **20**:464 (1893); Robinson & Fernald (1908) 40; Steagall (1927) 115.

Polystichum acrostichoides forma *incisum* (A.Gray) Gilb. List N. Am. Pterid. 19 (1901).

Type locality.—"In Pensylvania, Carolina, et Tennassée."

Range.—N. S.—Fla.—Tex.—Kans.—Wis.

Leaves lanceolate, pinnate, tufted, 30-60 cm. long; pinnae lanceolate, somewhat falcate, serrulate to dentate with bristle-tipped teeth, the fertile upper ones smaller, contracted. — Christmas Fern.

Common in wooded ravines, nearly throughout Illinois.

Two of the collections cited below (*Steagall 35* and *Evers 1283*) include specimens of the f. *incisum* with coarsely toothed pinnae. The Evers specimen has the "typical" form and the f. *incisum* growing from the same rhizome.

Specimens examined.—ADAMS CO.: Woods, Coe Springs, *Evers & Jones 518;* shady bank, without definite locality, July 27, 1878, *A. B. Seymour.* BROWN CO.: Common in wooded ravine, Siloam, *R. A. Evers 1283.* CHAMPAIGN CO.: Damp woods, Urbana, January 20, 1879, *A. B. Seymour;* Mahomet, July 31, 1884, *M. B. Waite;* woods, St.

Joseph to Sidney, September 16, 1899, *G. P. Clinton*. CLARK CO.: Woods, Rocky Branch, *G. N. Jones 12610*. COLES CO.: Fox Ridge State Park, *G. N. Jones 10686, 10689;* wooded ravine near Charleston, *G. N. Jones 17515*. FAYETTE CO.: Hickory Creek, *Louise Odell 472*. FULTON CO.: Sepo, *F. C. Gates 3699*. GALLATIN CO.: Wooded ravine, Olive Branch, *Mary M. Steagall 35;* Equality, *E. J. Palmer 17059* (MBG). HANCOCK CO.: Wooded ravine, Nauvoo, *F. C. Gates 10135*. HARDIN CO.: Elizabethtown, April 28, 1928, *C. J. Telford* (NHS). HENDERSON CO.: Oquawka, *H. N. Patterson & Florence Beaty*, September 1881. HENRY CO.: Cleveland, September 10, 1943, *L. R. Tehon* (NHS). JACKSON CO.: Makanda, *L. P. Cranwill* in 1917; rocky woods west of Makanda, *V. H. Chase 6613* (PAS); Fountain Bluff, *V. H. Chase 6633, 6635* (PAS). JERSEY CO.: Pere Marquette State Park, *Fuller & Link 108* (SM). JOHNSON CO.: Vienna, July 17, 1931, *J. Schopf* (NHS). LA SALLE CO.: Deer Park, *E. C. Piatt*, September 1880; rich sandy woods, Starved Rock, *Agnes Chase 1597*. LEE CO.: Franklin Grove, *E. Keithley 112* (SM). MCDONOUGH CO.: Without locality, *Pepoon & Barrett 4278* (NHS). MENARD CO.: Rich woods, common, New Salem State Park, *G. D. Fuller 3001;* hillsides, Athens, *E. Hall* in 1861. OGLE CO.: Shaded ravines, Oregon, August 27, 1882, *M. B. Waite*. PEORIA CO.: Shady hillsides, Peoria, *F. E. McDonald*, July 1892; rocky woods, Peoria, *F. E. McDonald*, June 1887; Peoria, *F. Brendel* (no number or date). PIKE CO.: Nebo, August 29. 1930, Campbell & *Alexopoulos* (NHS); Kinderhook, June 28, 1944, *G. H. Boewe* (NHS). POPE CO.: Herod, July 29, 1898, *G. P. Clinton;* Golconda, *E. J. Palmer 15444* (MBG). PULASKI CO.: Villa Ridge, June 12, 1869, *W. H. Russ;* Mounds, *E. J. Palmer 14847* (MBG); chestnut grove, Olmstead, August 29, 1916, *W. Trelease*. SALINE CO.: Still House Hollow, *G. H. Boewe* in 1936 (NHS). SANGAMON CO.: Auburn, *G. D. Fuller 6707* (SM). SCHUYLER CO.: Wooded bluffs, Sugar Creek, *Evers & Jones 582;* Pleasant View, *V. H. Chase 6936* (PAS). TAZEWELL CO.: Wooded hillsides, Groveland, *V. H. Chase 3107*. UNION CO.: Woods, Anna, August 13, 1880, *A. B. Seymour;* wooded slope, Bald Knob, *Mary M. Steagall 34;* State Forest, *G. D. Fuller 702;* Cobden, July 25, 1886, *F. S. Earle*. VERMILION CO.: Danville, June 24, 1886, *M. B. Waite*. WABASH CO.: Hanging Rock, *J. Schneck 103*, also July 27, 1880. WASHINGTON CO.: Without definite locality, *C. J. Hays* in 1878. WHITE CO.: Without locality, *Pepoon & Barrett 5169* (NHS). WILL CO.: Wooded banks of Hickory Creek, Mokena, November 6, 1899, *E. J. Hill*.

[*Aspidium lonchites*, listed by Huett (1897) 132, is *Polystichum lonchitis* (L.) Roth, probably a misidentification of *P. acrostichoides* (Michx.) Schott]

7. DRYOPTERIS Adans.

Leaves of one kind, the fertile and sterile alike; stipes green or pale brown, coarse, often somewhat chaffy, not jointed to the rhizome; sori dorsal, roundish; indusium superior, orbicular-reniform, attached by its sinus, or in some species lacking. — *Aspidium* Sw. in part; *Thelypteris* Schmidel; *Phegopteris* (Presl) Fée.

1. Indusium none; leaves triangular; rhizomes slender, horizontal.
   2. Leaves ternate, glabrous, the three divisions stalked; rachis not winged ..... *D. disjuncta*
   2. Leaves twice pinnatifid, pubescent or glandular beneath, the pinnae all sessile, adnate to the rachis.
      3. Rachis terete and wingless above the lowest pair of pinnae ..... *D. phegopteris*
      3. Rachis winged above the lowest pair of pinnae by their adnate bases ..... *D. hexagonoptera*

1. Indusium present.
   4. Leaves membranous, not evergreen; vascular bundles of the stipe two, free or united; rhizomes slender, almost without scales.
      5. Lowest pinnae reduced in length, widely spaced, deflexed, the blade therefore

conspicuously narrowed at the base; margins of the pinnules flat; indusium glandular; veins mostly simple ..... *D. noveboracensis*

5. Lowest pinnae only slightly reduced; margins of the pinnules revolute; indusium ciliate; veins of the sterile blades forked ..... *D. thelypteris*

4. Leaves of firm texture, often evergreen; vascular bundles of the stipe five or more; rhizome stout, conspicuously scaly.

6. Leaves 1-pinnate, or rarely 2-pinnate.

7. Sori along the margins of the obscurely crenate or entire pinnules; leaves coriaceous ..... *D. marginalis*

7. Sori near the midvein; pinnules toothed.

8. Leaf-blades 20-40 cm. wide, ovate in outline, scarcely narrowed below; pinnae broadest near the middle ..... *D. goldiana*

8. Leaf-blades narrower, elliptical in outline, narrowed at the base; lower pinnae broadest at the base ..... *D. cristata*

6. Leaves 2-3-pinnate, the pinnae spinulose-toothed.

9. Pinnae at right angles to the rachis; inner pinnules of the basal row equalling or shorter than the next outer ones; leaves (at least the rachis) usually with a few small scattered stipitate glands; indusium with marginal glands ..... *D. intermedia*

9. Pinnae oblique to the rachis; inner pinnules of the basal row longer than the next outer ones; leaves and indusia not glandular ..... *D. spinulosa*

DRYOPTERIS DISJUNCTA (Ledeb.) Morton in Rhodora **43**:217 (1941).

Polypodium dryopteris L. Sp. Pl. 1093 (1753); Lapham (1857) 549.

Polypodium dryopteris γ *disjunctum* Ledeb. Fl. Ross. **4**:509 (1853).

Polypodium disjunctum Rupr. ex Schur in Oesterr. Bot. Zeit. **8**:193 (1858).

Phegopteris dryopteris (L.) Fée, Gen. Fil. 243 (1850-52); Jones (1945) 37.

Type locality.—Sitka, Alaska.

Range.—Greenl.—Newf.—Va.—Iowa—S.D.—Colo.—Ariz.—Ore.—Alaska. Eurasia.

Rhizomes slender; leaves ternate, triangular, glabrous, the three primary divisions stalked, subequal, spreading; sori submarginal. — Oak Fern.

Wooded ravines, rare.

Specimens examined.—OGLE CO.: Rocky woods, Oregon, August 11, 1885, *M. B. Waite;* Oregon, June 23, 1946, *E. W. Fell* (SM). ST. CLAIR CO.: Without definite locality, *F. Brendel* in 1850.

DRYOPTERIS PHEGOPTERIS (L.) C.Chr. Ind. Fil. 284 (1905).

Polypodium phegopteris L. Sp. Pl. 1089 (1753).

Polypodium connectile Michx. Fl. Bor. Am. **2**:271 (1803).

Phegopteris polypodioides Fée, Gen. Fil. 243 (1850-52); Patterson (1876) 53; Brendel (1887) 89; Huett (1897) 132; Hill (1912a) 39.

Phegopteris connectilis (Michx.) Watt in Canad. Nat. II. **3**:159 (1866); Jones (1945) 37.

Type locality.—"Habitat in Europae fagetis et in Virginia."

Range.—Greenl.—Newf.—Va.—Minn.—Man.—Ore.—Alaska. Europe

Leaves bipinnatifid, triangular, mostly longer than broad, short-pubescent, especially on the veins; rachis terete and wingless above the lowest pair of pinnae, which are deflexed; sori submarginal. — Long Beech Fern.

Moist ravines, cliffs, and woods, rare.

Specimens examined.—HENDERSON CO.: Oquawka, *H. N. Patterson 57* (FM). LA SALLE CO.: Moist ravine, Starved Rock, July 18, 1901, *E. J. Hill;* sandstone walls of Wildcat Canyon, *Agnes Chase 1589;* Starved Rock, September 3, 1882, *A. B. Seymour, G. D. Fuller 1755* (FM). OGLE CO.: Moist sandy ravine, three miles south of Oregon, *G. D. Fuller 10241.* PULASKI CO.: Karnak, August 6, 1946, *G. H. Boewe* (NHS).

DRYOPTERIS HEXAGONOPTERA (Michx.) C.Chr. Ind. Fil. 270 (1905); Fuller (1943) 91, (1946) 52.

Polypodium hexagonopterum Michx. Fl. Bor. Am. **2**:271 (1803); Lapham (1857) 549; Brendel (1860) 294; French (1870) 383.

Phegopteris hexagonoptera (Michx.) Fée, Gen. Fil. 243 (1850-52); Patterson (1874) 18, (1876) 53; Schneck (1876) 575; Brendel (1887) 65; Higley & Raddin (1891) 150; Huett (1897) 132; Hill (1912a) 39; Palmer (1921) 134; Pepoon (1927) 143; Steagall (1927) 115; Stover (1930) 26; Jones (1945) 37.

Type locality.—"In Carolina et Virginia."

Range.—Que.—Fla.—La.—Minn.

Leaves triangular, about as wide as long, or wider, the lower surface finely glandular and often slightly pubescent; basal pair of pinnae usually longer than the others. — Broad Beech Fern.

Rich woods and ravines, not uncommon.

Specimens examined.—ADAMS CO.: Sugar Creek, *Evers & Jones 614.* ALEXANDER CO.: Deep moist woods, common, Thebes, August 1, 1917, *L. P. Cranwill;* woods, Horseshoe Island, *G. N. Jones 12063.* BROWN CO.: Wooded ravine, Siloam, *R. A. Evers 1282.* CALHOUN CO.: Kampsville, *L. M. Turner 790* (FM). CARROLL CO.: Palisades State Park, *G. N. Jones 17289.* CASS CO.: Chandlerville, August 12, 1886, *A. B. Seymour.* CLARK CO.: Rocky Branch, *H. S. Pepoon 5053* (NHS). COLES CO.: Wooded ravine near Charleston, *G. N. Jones 17514.* COOK CO.: Desplaines, rich woods, frequent, *W. S. Moffatt 1788.* HARDIN CO.: Elizabethtown, June 24, 1931, *J. Schopf* (NHS). HENDERSON CO.: In ravines among the bluffs, without definite locality, *H. N. Patterson* in 187... JACKSON CO.: Fountain Bluff, *V. H. Chase 6664* (PAS). JERSEY CO.: Pere Marquette State Park, *Fuller & Link* (SM). JOHNSON CO.: Near Vienna, July 17, 1931, *J. Schopf* (NHS); Goreville, July 27, 1931, *J. Schopf* (NHS). LEE CO.: Franklin Creek, *G. N. Jones 15832.* MACOUPIN CO.: Carlinville, July 9, 1889, *W. E. Andrews.* MARION CO.: Salem, *M. S. Bebb,* no number or date (FM). MENARD CO.: Athens, *E. Hall* in 1861 (FM). OGLE CO.: Castle Rock, July 5, 1945, *E. W. Fell* (SM). PEORIA CO.: Peoria, *F. Brendel* (no number or date); rich wooded hillside, Limestone Tp., *V. H. Chase 3183* (PAS); Medina, *V. H. Chase 6918* (PAS). POPE CO.: Herod, August 2, 1898, *G. P. Clinton.* ST. CLAIR CO.: Without definite locality, *F. Brendel,* July 1850. SCHUYLER CO.: Wooded bluffs of Sugar Creek, *Evers & Jones 583.* TAZEWELL CO.: Without definite locality, *F. E. McDonald,* August 1889; shady bank, south of East Peoria, *V. H. Chase 6907* (PAS); south of Creve Coeur, *V. H. Chase 4909* (PAS). UNION CO.: Cobden, June 16, 1909, *I. S. Raymond;* Alto Pass, *G. D. Fuller 720;* Anna, July 13, 1880, *A. B. Seymour.* VERMILION CO.: Without definite locality, June 24, 1880, *A. B. Seymour;* Danville, June 24, 1886, *M. B. Waite.* WABASH CO.: Hanging Rock, *J. Schneck 101;* Mt. Carmel, August 5, 1887, *M. B. Waite.* WHITE CO.: Enfield, *Pepoon & Barrett 5158* (NHS). WILL CO.: Joliet, *H. C. Skeels 395* (FM).

DRYOPTERIS THELYPTERIS (L.) A.Gray, Man. Bot. 630 (1848); Fuller (1943) 91; Jones (1945) 36.

Acrostichum thelypteris L. Sp. Pl. 1071 (1753).

Aspidium thelypteris (L.) Sw. in Schrad. Journ. Bot. 1800^2: 40 (1801); Vasey

(1860) 119, (1861) 143; Babcock (1873) 98; Patterson (1876) 53; Schneck (1876) 575; Brendel (1887) 65; Huett (1897) 132; Higley & Raddin (1891) 150; Gates (1912) 353; Sherff (1913) 593; Thone (1925) 101; Pepoon (1927) 145.

Nephrodium thelypteris (L.) Strempel, Fil. Berol. Syn. 32 (1822); Hill (1913a) 39.

Lastrea thelypteris β *pubescens* Laws. in Edinb. New Philos. Journ. II. **19**:277 (1864).

Dryopteris thelypteris var. *pubescens* (Laws.) A. R. Prince ex Weatherby in Am. Fern Journ. **26**:95 (1936); Fuller (1946) 52.

Type locality.—Northern Europe.

Range.—Que.—Fla.—Tex.—Nebr.—Man.; Eurasia.

Leaves 1-pinnate, lanceolate, scarcely narrowed at the base, arising from a slender rhizome; pinnae linear-lanceolate, pinnatifid, sparsely pubescent beneath varying to nearly or quite glabrous; segments oblong, obtuse; sori median; indusia glabrous on the surface, the margin toothed or sparsely ciliate. — Marsh Fern.

Marshes, swamps, bogs, moist woods, and ditches, common.

Specimens examined.—BOONE CO.: Capron, September 20, 1945, *E. W. Fell* (SM). CARROLL CO.: Savanna, October 4, 1887, *M. B. Waite*. CHAMPAIGN CO.: Woods, Urbana, August 8, 1888, *G. P. Clinton*. COOK CO.: Low sandy ground, Rose Hill, Chicago, May 21, 1896, *Agnes Chase;* Chicago, *W. W. Wright 209, 210* (FM). FULTON CO.: Opposite Havana, *T. J. Burrill* in 1894. GALLATIN CO.: Sandy swamps, Inman, *E. J. Palmer 15551*. HENRY CO.: Without definite locality, July 29, 1943, *R. J. Dobbs* (NHS). KANE CO.: Wet swampy soil, Elgin, *E. E. Sherff 1990, H. C. Benke 4660* (FM). KANKAKEE CO.: St. Anne, *G. N. Jones 11422, 11523;* marshes and sloughs, Kankakee, August 31, 1872, *E. J. Hill;* Bonfield, *G. N. Jones 15882*. LAKE CO.: Bog, Cedar Lake, *Mary M. Steagall 8, G. N. Jones 15222*, sphagnum bog, *Gleason & Shobe 125;* moist woods, Antioch, *G. N. Jones 16506, G. D. Fuller 9239* (SM), bog, Volo, *G. N. Jones 15137;* Beach, *F. C. Gates 2801, 2929;* tamarack swamp, Wauconda, September 21, 1904, *E. J. Hill;* swale, Waukegan, *F. C. Gates 2501*. LA SALLE CO.: Starved Rock, *F. Thone 90*. LEE CO.: Wet original prairie, Amboy, *V. H. Chase 4678* (PAS). MASON CO.: Quiver Beach, *F. C. Gates 3840;* Lake Matanzas, *F. C. Gates 3730, 3757*. McHENRY CO.: Ringwood, *G. Vasey* (no number or date). PEORIA CO.: Peoria, *F. Brendel* (no number or date). PULASKI CO.: Pulaski, September 24, 1931, *Pepoon & Barrett* (NHS). SANGAMON CO.: Wet fields, occasional, *G. D. Fuller 7915*. TAZEWELL CO.: Bog near East Peoria, *V. H. Chase 3310*. VERMILION CO.: Marshy ground, without locality, June 24, 1880, *Seymour & Butts*. WABASH CO.: Swamp, Patout, October 12, 1880, *J. Schneck;* Mt. Carmel, August 1887, *J. Schneck*. WINNEBAGO CO.: Slough marsh near Shirland, *E. W. Fell 45466;* Fountaindale, *M. S. Bebb*, no number or date (FM). WOODFORD CO.: Cold bogs near Upper Ferry, *F. E. McDonald*, August 1891; cold swamp on Spring Bay Road, August 1890, *F. E. McDonald*.

DRYOPTERIS NOVEBORACENSIS (L.) A.Gray, Man. Bot. 630 (1848); Palmer (1921) 134; Jones (1945) 36; Fuller (1946) 52.

Polypodium noveboracense L. Sp. Pl. 1091 (1753).

Aspidium noveboracense (L.) Sw. in Journ. Bot. Schrad. 18002: 38 (1801); Patterson (1876) 53; Schneck (1876) 575; Brendel (1887) 89; Pepoon (1927) 146.

Nephrodium noveboracense (L.) Desv. Mém. Soc. Linn. **6**:257 (1827); Hi'l (1912a) 39.

Type locality.—"Habitat in Canada."

Range.—Newf.—Mich.—Ark.—Ga

Leaves thin, yellowish green, 30-60 cm. long, from a slender rhizome, 1-pinnate, elliptical-lanceolate, acuminate, the pinnae lanceolate, pinnatifid, acuminate, pubescent along the veins; segments obtuse; indusia glandular. — New York Fern.

Woods and thickets, rare.

Specimens examined.—JACKSON CO.: Woods, Makanda, August 19, 1880, *A. B. Seymour.* KANE CO.: Elgin, *G. Vasey* (no number or date). MONROE CO.: Sandstone ledge, Rock House Creek, *Mary M. Steagall 5.*

DRYOPTERIS MARGINALIS (L.) A.Gray, Man. Bot. 632 (1848); Ries (1939) 90; Jones (1945) 37, (1946) 52.

Polypodium marginale L. Sp. Pl. 1091 (1753).

Aspidium marginale (L.) Sw. in Schrad. Journ. Bot. 1800**2**: 35 (1801); French (1870) 383; Patterson (1876) 54; Brendel (1887) 89; Huett (1897) 132; Thone (1925) 101; Steagall (1927) 115; Stover (1930) 25.

Nephrodium marginale (L.) Michx. Fl. Bor. Am. **2**:267 (1803); Hill (1912a) 39.

Type locality.—"Habitat in Canada."

Range.—Que.—N.S.—Ga.—Okla.—Sask.

Leaves coriaceous, usually nearly or quite bipinnate; rhizome scaly; pinnae lanceolate, the segments lanceolate, obtusish, nearly entire; sori marginal; indusia glabrous. — Marginal Wood Fern.

Sandstone cliffs and wooded ravines, not uncommon.

Specimens examined.—CALHOUN CO.: Kampsville, *L. M. Turner 281* (FM). COOK CO.: Evanston, *P. Blatchford 2553* (SM). HANCOCK CO.: Augusta, October 23, 1857, *S. B. Mead* (FM). JACKSON CO.: Carbondale, *A. F. Whiting 1783* (FM), rocky hillside, *J. McCree 615, 957;* Fountain Bluff, *V. H. Chase 6634* (PAS); rocky hillside, Grand Tower, August 3, 1900, *H. A. Gleason;* Makanda, August 19, 1880, *A. B. Seymour,* on rocks, common, July 23, 1917, *L. P. Cranwill,* rocky woods, *G. N. Jones 11925.* JOHNSON CO.: Rich rocky soil, Tunnel Hill, May 26, 1902, *J. Schneck;* Glen Fern, August 30, 1890, *J. Schneck.* KANE CO.: Elgin, *G. Vasey* (no number or date). LAKE CO.: Lake Forest, ... *Wilson 32.* LA SALLE CO.: rocky bluff, Utica, July 13, 1901, *E. J. Hill;* Little Deer Park, *E. C. Piatt,* September 1880; Starved Rock State Park, *F. Thone 24, G. N. Jones 16979;* Starved Rock, *Agnes Chase 1581, Greenman, Lansing & Dixon 23* (FM). OGLE CO.: White Pines Forest State Park, October 13, 1945, *E. W. Fell* (SM). POPE CO.: Herod, July 27, 1898, *G. P. Clinton;* Thackers Gap, *G. P. Clinton,* August 1898. SALINE CO.: Womble Mt., *W. E. Andrews,* June 1906. UNION CO.: On boulders in gravelly soil, very common, Fountain Bluff, July 28, 1917, *L. P. Cranwill;* sandstone bluff, Bald Knob, *Mary M. Steagall 4;* Cobden, August 18, 1880, *A. B. Seymour,* June 8, 1885, *Earle & Waite.* VERMILION CO.: Danville, *F. C. Gates 1355* (FM).

DRYOPTERIS GOLDIANA (Hook.) A.Gray, Man. Bot. 631 (1848); Jones (1945) 37.

Aspidium goldianum Hook. ex Goldie in Edinb. Philos. Journ. **6**:333 (1822); Vasey (1860) 119, (1861) 143; Forbes (1870) 318; Patterson (1876) 89; Brendel (1887) 89; Huett (1897) 132.

Nephrodium goldianum (Hook.) Hook. & Grev. Icon. Fil. pl. 102 (1829); Hill (1912a) 39.

Type locality.—Near Montreal, Canada.

Range.—N.B.—N.C.—Tenn.—Iowa—Minn.

Leaves ovate in outline, short-acuminate, twice-pinnate; stipe scaly; pinnae lanceolate, pinnatifid, 1-2.5 cm. long; segments acute, serrate; sori near the midrib; indusia glabrous. — Goldie's Fern.

Rich woods in ravines, rare.

Specimens examined.—FULTON CO.: Without definite locality, *F. Brendel, J. Wolf* (no number or date). GRUNDY CO.: Morris, *G. Vasey* (no number or date). LA SALLE CO.: In marsh, Starved Rock, *Mary M. Steagall 3.* McLEAN CO.: Twin Grove, *Robinson* in 1881. PEORIA CO.: Without locality, *J. T. Stewart*, no number or date (FM).

DRYOPTERIS CRISTATA (L.) A.Gray, Man. Bot. 631 (1848); Jones (1945) 37.

Polypodium cristatum L. Sp. Pl. 1090 (1753).

Nephrodium cristatum (L.) Michx. Fl. Bor. Am. **2**:269 (1803); Hill (1912a) 39.

Type locality.—"Habitat in Europa septentrionali."

Range.—Newf.—Va.—Nebr.—Ida.—Mack.; Europe.

Leaves from a short stout rhizome, the fertile erect, longer than the sterile, all bipinnatifid, the segments, oblong, obtuse, serrate; sori medial; indusia smooth. — Crested Wood Fern.

Swampy woods in the northern part of the state, rare.

Specimens examined.—BOONE CO.: Roscoe, June 27, 1945, *E. W. Fell* (SM). COOK CO.: Wheeling, *C. D. Fuller 10772* (SM). KANKAKEE CO.: Kankakee, *R. Schneider* in 1935. LAKE CO.: Bog, Cedar Lake, *Mary M. Steagall 2;* bog, Volo, *C. N. Jones 15130.* OGLE CO.: Moist pine woods, rare, White Pines Forest State Park, *C. D. Fuller 3510, E. W. Fell 45543.* WINNEBAGO CO.: Perryville, *C. D. Fuller 11230* (SM).

DRYOPTERIS INTERMEDIA (Muhl.) A.Gray, Man. Bot. 630 (1848); Jones (1945) 37.

Aspidium intermedium Muhl. ex Willd. Sp. Pl. **5**:262 (1810).

Aspidium spinulosum var. *intermedium* (Muhl.) D.C.Eaton in A.Gray, Man. Bot. (ed. 5) 665 (1867); Babcock (1873) 98; Patterson (1876) 53; Higley & Raddin (1891) 150; Pepoon (1927) 147; Steagall (1927) 115.

Dryopteris spinulosa var. *intermedia* (Muhl.) Underw., Our Native Ferns (ed. 4) 116 (1893); Weatherby (1936) 66.

Nephrodium spinulosum var. *intermedium* (Muhl.) Davenp. ex Gilb. List N. Am. Pterid. 17 (1901); Hill (1912a) 39.

Type locality.—Pennsylvania.

Range.—Newf.—N.C.—Tenn.—Wis.—Minn.—Tex.

Leaves 20-100 cm. long, usually with a few scattered stipitate glands at least along the rachis; pinnae tending to be set at right angles to the rachis; inner pinnules of the basal row equalling or shorter than the next outer ones; scales of the stipe often with a dark center; indusia with small marginal glands. — Common Wood Fern.

Moist woods locally throughout Illinois except the eastern and central counties.

Specimens examined—COOK CO.: Woods, Elmhurst, *W. S. Moffatt 282.* JACKSON CO.: Makanda, *F. S. Earle* (no number or date), August 19, 1880, *A. B. Seymour.* JOHNSON CO.: On sandstone, Benson Bluff, *Mary M. Steagall 6.* LAKE CO.: Dried-out tamarack grove, Lake Villa, *H. A. Gleason & F. D. Shobe 102.* LA SALLE CO.: Talus.

Starved Rock, *Mary M. Steagall 7;* Starved Rock, *F. Thone 229, 237;* rich woods, base of sandstone cliff, Starved Rock, *Agnes Chase 1587.* LEE CO.: Prairieville, October 31, 1945, *G. H. Boewe* (NHS). MCHENRY CO.: Ringwood, *G. Vasey* (no number or date). PEORIA CO.: Peoria, *F. Brendel* (no number or date); rich woods west of Bartonville, *V. H. Chase 6924* (PAS).

DRYOPTERIS SPINULOSA (O. F. Muell.) Watt in Canad. Nat. II 3:159, 403 (1866); Jones (1945) 37; Fuller (1946) 52.

Polypodium spinulosum O.F.Muell. Fl. Fridr. 193. 1767, described but not named; Fl. Dan. **4**:7, t. 707 (1770).

Aspidium spinulosum (O.F.Muell.) Sw. in Schrad. Journ. Bot. 18002: (1801) 38; Brendel (1887) 65; Huett (1897) 132; Thone (1925) 101; Pepoon (1927) 146.

Type locality.—Denmark.

Range.—Newf.—Va.—Minn.—Ida.—B.C.—Alaska; Europe.

Leaves 2-10 cm. long, glabrous; pinnae oblique to the rachis; inner pinnules of the basal row longer than the next outer ones; scales of the stipe pale brown throughout; indusia glandless. — Spinulose Wood Fern.

Woods, rare.

Specimens examined.—JO DAVIESS CO.: Apple River Canyon State Park, *G. D. Fuller 9428* (SM). LAKE CO.: Antioch, *G. N. Jones 16507.* OGLE CO.: Oregon, *M. B. Waite* in 1883. PEORIA CO.: Peoria, *F. Brendel.* WINNEBAGO CO.: Rockton, November 11, 1945, *E. W. Fell;* Roscoe, June 27, 1945, *E. W. Fell* (SM).

8. POLYPODIUM L.—Polypody

Ferns with pinnatifid leaves (in our species) distinctly jointed to and arising singly from roundish projections on the chaffy, creeping, branched rhizome; sori dorsal, round, lacking indusia.

1. Leaves glabrous on both sides ..... *P. virginianum*
1. Leaves copiously grayish-scurfy beneath ..... *P. polypodioides*

POLYPODIUM VIRGINIANUM L. Sp. Pl. 1085 (1753); Jones (1945) 38.

Polypodium vulgare sensu Bebb (1859) 587, (1860) 183; Vasey (1861) 143; French (1870) 383; Patterson (1876) 53; Brendel (1887) 89; Huett (1897) 131; Hill (1912a) 37; Thone (1925) 101; Steagall (1927) 115. — Non L. (1753).

Type locality.—Virginia.

Range.—Newf.—Ga.—Ala—Man.

Rhizome horizontal, spongy; leaves 10-30 cm. long and 3-6 cm. wide, glabrous on both sides, deeply pinnatifid, the lobes shallowly toothed or entire, obtuse; sori large, half way between midrib and margin. — Common Polypody.

Rocky ledges, locally abundant.

Specimens examined.—GALLATIN CO.: Shawneetown, August 15, 1931, *J. Schopf* (NHS). JACKSON CO.: Makanda, August 19, 1880, *A. B. Seymour,* moist shaded rocks, July 16, 1902, *H. A. Gleason;* Carbondale, *J. McCree 610, 961.* JOHNSON CO.: Sandstone, Tunnel Hill, *E. J. Palmer 15213* (MBG), *B. F. Bush 6915* (MBG), May 26, 1902, *J. Schneck;* Vienna, *E. J. Palmer 14982* (MBG). KANKAKEE CO.: Rock Creek, *V. O. Graham 9321* (SM). LAKE CO.: Cedar Lake, September 29, 1887, *M. B. Waite.* LA SALLE CO.: Deer Park, *E. C. Piatt,* September 1880; Starved Rock, *F. Thone 58;* sandstone cliff, Starved Rock, *Agnes Chase 1585;* sandstone cliffs, bluffs of Illinois River, Utica, July 13, 1901, *E. J. Hill.* OGLE CO.: Oregon, *M. S. Bebb* (no

number or date); sandstone rocks, July 8, 1905 and July 10, 1905, *E. J. Hill;* rocks, Oregon, August 15, 1882 and September 8, 1885, *M. B. Waite, W. S. Moffatt 454.* POPE CO.: On Pottsville sandstone, Jackson Hollow, *Mary M. Steagall 33;* Brownfield, *E. J. Palmer 15404* (MBG). UNION CO.: Moist cliffs, Fountain Bluff, July 25, 1917, *L. P. Cranwill;* cliffs, Alto Pass, *G. D. Fuller 715;* without definite locality, *F. Brendel* in 1860. WABASH CO.: Mt. Carmel, *J. Schneck* (no number or date).

POLYPODIUM POLYPODIOIDES (L) Watt in Canad. Nat. II, 3:158 (1866); Gleason (1903) 2; Hill (1912a) 37; Steagall (1927) 115.

Acrostichum polypodioides L. Sp. Pl. (ed. 2) 1525 (1763).

Polypodium incanum Sw. Prodr. 131 (1788); Lapham (1857) 549; Forbes (1870) 318; Patterson (1876) 53; Schneck (1876) 574; Brendel (1887) 89.

Polypodium ceteraccinum Michx. Fl. Bor. Am. **2**:271 (1803); Jones (1945) 38.

Polypodium polypodioides var. *michauxianum* Weatherby in Contr. Gray Herb. **124**:31 (1939); Deam (1940) 59.

Type locality.—Virginia and Jamaica.

Range.—Md.—Fla.—Tex.—S. Ill.; W. Ind.; S. Am.; S. Afr.

Rhizome horizontal, woody; scales small, brown; leaves 10-30 cm. long, curled up in dry weather; stipe densely scurfy; lobes obtuse, glabrous above, densely scurfy beneath with grayish peltate scales; sori small, submarginal.—Gray Polypody. Resurrection Fern.

On rocks, rarely on trees, in southern Illinois.

Specimens examined.—JACKSON CO.: Dry sandstone cliffs, Grand Tower, August 23, 1900, *H. A. Gleason;* Fountain Bluff, *Fuller & Welch 165* (SM). JOHNSON CO.: Sand rock, common, Tunnel Hill, *E. J. Palmer 15223* (MBG), May 26, 1902, *J. Schneck;* Glen Fern, July 30, 1900, *M. Craig.* POPE CO.: Herod, July 27, 1898, *G. P. Clinton;* Brownfield, *E. J. Palmer 15405* (MBG). PULASKI CO.: Karnak, August 30, 1916, *W. B. McDougall 129.* UNION CO.: *Cobden,* June 17, 1869, *I. S. Raymond, F. Brendel* in 1860; Alto Pass, *E. J. Palmer 15033* (MBG).

9. CAMPTOSORUS Link

Rhizome short; leaves simple, acuminate, entire or slightly sinuate, net-veined; sori roundish to linear-oblong, scattered on each side of the veins; indusia membranous, attached at one side of the sori.

CAMPTOSORUS RHIZOPHYLLUS (L.) Link, Hort. Berol. 2:69 (1833); Lapham (1857) 549; Forbes (1870) 318; French (1870) 383; Patterson (1876) 53; Schneck (1876) 575; Brendel (1887) 65; Huett (1897) 132; Gleason (1903) 2; Hill (1912a) 38; Pepoon (1927) 145; Steagall (1927) 115; Stover (1930) 26; Palmer (1936) 138; Jones (1945) 38; Fuller (1946) 52.

Asplenium rhizophyllum L. Sp. Pl. 1078 (1753); Mead (1846) 121.

Type locality.—Eastern North America.

Range.—Que.—Ga.—Ala.—Kans.—Minn.

Leaves 5-30 cm. long, clustered, evergreen, lanceolate, entire, the base auricled, the apex long-attenuate, often rooting at the tip and thus producing new plants. — Walking Fern.

Moist rocky ledges, not rare.

Specimens examined.—CARROLL CO.: Savanna, October 15, 1887, *M. B. Waite.* COOK CO.: Shaded calcareous rocks, Sag Bridge, June 25, 1909, *E. J. Hill.* HENDERSON CO.: Oquawka, *H. N. Patterson* (no date or number). JACKSON CO.: Fountain Bluff, *Bauer 2353;* rocks, Makanda, August 19, 1880, *A. B. Seymour;* limestone cliff, Grand Tower, May 2, 1897, *F. M. Woodruff;* moist sandstone cliffs, Grand Tower, August 18, 1900, *H. A. Gleason.* JERSEY CO.: Pere Marquette State Park, *Fuller & Link 12* (SM). JO DAVIESS CO.: Rock ledge, Smallpox Creek, *V. H. Chase 6809* (PAS); without locality, *Pepoon & Moffatt 206.* JOHNSON CO.: Sandstone bluffs, Tunnel Hill, May 26, 1902, *J. Schneck.* KANE CO.: Elgin, *G. Vasey* (no number or date). LA SALLE CO.: Baileys Falls, *F. Brendel,* August 1883; Oglesby, June 2, 1906, *H. C. Cowles* (SM). LEE CO.: Shaded limestone cliffs, Franklin Grove, *G. D. Fuller 7452.* OGLE CO.: Shaded sand rocks, Oregon, August 1881, *M. B. Waite.* PEORIA CO.: Peoria, *F. Brendel* (no number or date); bare faces of cliffs, Rocky Glen, Peoria, July 8, 1892, *F. E. McDonald.* POPE CO.: Sandstone, Jackson Hollow, *Mary M. Steagall 17;* without locality, February 1893, *Balcom;* Thackers Gap, August 1898, *G. P. Clinton.* ST. CLAIR CO.: Falling Spring, *F. Brendel* in 1851 (PAS). TAZEWELL CO.: Sandstone cliff, East Peoria, *V. H. Chase 4238* (PAS). UNION CO.: Moist rocks, Cobden, August 18, 1880, *A. B. Seymour.* WABASH CO.: Hanging Rock, *J. Schneck 120.* WILL CO.: Shaded limestone ledge, April 6, 1908, Lockport, *E. J. Hill;* limestone ledges, Joliet, October 8, 1901, *E. J. Hill.* WILLIAMSON CO.: Rocky bluff, Grassy Creek. *J. McCree 663.* WINNEBAGO CO.: Without locality, *M. S. Bebb* (no date or number) (FM); Rockford, *G. D. Fuller 10149* (SM); Roscoe, July 24, 1945, *E. W. Fell* (SM).

10. ASPLENIUM L.—Spleenwort

Small ferns with erect or ascending rhizomes and small tufted evergreen pinnate leaves; veins free; stipe and rachis firm, slender, wiry; sori dorsal, oblong or linear, oblique to the midvein; indusium superior, attached by one edge to the vein.

1. Rachis green, flat.
   2. Leaves pinnatifid, or pinnate below, lanceolate, tapering to a long, narrow tip, the segments obtuse, crenate ..... *A. pinnatifidum*
   2. Leaves 2-3-pinnate, rhombic in outline, the segments cuneate, finely toothed at the apex ..... *A. cryptolepis*
1. Rachis black or brown, terete.
   3. Leaves pinnatifid, the apex caudate, the segments lanceolate, sessile, variable in size, more or less auriculate at the base ..... ×*A. ebenoides*
   3. Leaves pinnate, with 15-40 pairs of pinnae.
      4. Pinnae auriculate on upper side near base, serrate.
         5. Leaves uniform, all fertile; pinnae mostly opposite, elliptical; rachis black ..... *A. resiliens*
         5. Leaves dimorphous, the sterile smaller, spreading; pinnae alternate, lanceolate; rachis chestnut brown ..... *A. platyneuron*
      4. Pinnae crenate, oval, obtuse, not auriculate ..... *A. trichomanes*

ASPLENIUM PINNATIFIDUM Nutt. Gen. 2:251 (1818); Forbes (1870) 318; French (1870) 383; Patterson (1876) 53; Schneck (1876) 575; Brendel (1887) 89; Hill (1912a) 38; Steagall (1927) 115; Jones (1945) 38.

Type locality.—"In the crevices of rocks on the banks of the Schuykill.," Lancaster County, Pennsylvania.

Range.—N.J.—Ga.—Okla.—Ind.

Rhizome short, chaffy; stipes glossy, blackish below; leaves tufted, lanceo-

late, coriaceous, 5-25 cm. long, pinnatifid, tapering to a narrow apex; sori numerous, slightly curved, confluent in age. — Pinnatifid Spleenwort.

Sandstone cliffs, rare, southern Illinois.

Specimens examined.—FULTON CO.: Canton, *J. Wolf* (SM). GALLATIN CO.: On sandstone, Pounds, *Mary M. Steagall 13*. JACKSON CO.: Makanda, *C. H. French*, July 1870 (FM), *V. H. Chase 6275* (PAS); Carbondale, *Fuller & Welch 611, 960* (SM). JOHNSON CO.: Sandstone bluffs, common, Tunnel Hill, May 27, 1902, *J. Schneck*; on sandstone rocks, Glen Fern, July 30, 1890, *M. Craig*. POPE CO.: Glendale, August 13, 1931, *J. Schopf* (NHS). SALINE CO.: Stonefort, *J. Schneck 117*; Womble Mt., June 6, 1906, *W. E. Andrews*. UNION CO.: Cobden, June 16, 1869, *I. S. Raymond*, August 14, 1880, *A. B. Seymour*, July 26, 1886, *F. S. Earle*.

ASPLENIUM CRYPTOLEPIS Fernald in Rhodora 30:41 (1928); Jones (1945) 38.

Asplenium ruta-muraria sensu Robins. & Fernald (1908) 39; Britton & Brown (1913) 29. — Non L. (1753).

Type locality.—Sheffield, Massachusetts.

Range.—Vt.—Mich.—Mo.—Ark.—Ala.

Rhizome short, ascending; leaves 2-3-pinnate, rhombic in outline, glabrous, evergreen; pinnules cuneate, obtuse, dentate or incised; sori few, confluent at maturity. — Rue Spleenwort.

Usually on calcareous cliffs. Southern Illinois, without definite locality, *F. Brendel*.

× ASPLENIUM EBENOIDES R. R. Scott in Gard. Monthly 7:267 (1865); Slosson (1902) 487-495; Hill (1912a) 38; Steagall (1927) 116; Jones (1945) 38.

× *Asplenosorus ebenoides* (R. R. Scott) Wherry in Am. Fern Journ. 27:56 (1937); Palmer (1936) 138.

Asplenium platyneuron × *Camptosorus rhizophyllus*.

Type locality.—Near Philadelphia.

Range.—Vt.—N.C.—Ala.—Mo.—Ill.

Rhizome short, chaffy; leaves tufted, lanceolate in outline, tapering to an acuminate apex, pinnatifid, or pinnate below, the segments lanceolate, acuminate, irregular; stipes brown throughout.— Scott's Spleenwort.

Dr. Mary M. Steagall says "This was found but once near Ava [Jackson County], by Mr. John Marten a number of years ago. The single specimen was identified by Dr. Asa Gray as *Asplenium ebenoides*. It was destroyed by the fire which burned the Normal Building, November 26, 1883."— Steagall (1927) 116.

This fern was also reported from Jackson County, anonymously and without confirming evidence, in the Fern Bulletin, vol. 5, p. 13.

The Palmer collection cited below consists of two small plants. In the relative length of stipe and blade, the shape of the irregularly pinnatifid blades, and the reddish brown stipe, these plants appear to belong to × A. *ebenoides*.

Specimens examined.—ALEXANDER CO.: On chert boulder, with *A. platyneuron* and *Camptosorus rhizophyllus*, McClure, April 22, 1919, *E. J. Palmer 14909b* (MBG).

ASPLENIUM PLATYNEURON (L.) Oakes ex D. C. Eaton, Ferns N. Am. 1:24 (1878); Gleason (1903) 2; Hill (1912a) 38; Steagall (1927) 115; Palmer (1936) 138; Fuller (1943) 91; Jones (1945) 38.

Acrostichum platyneuros L. Sp. Pl. 1069 (1753).

Asplenium ebenum Ait. Hort. Kew. **3**:462 (1789); Brendel (1859) 585; Vasey (1861) 143; Forbes (1870) 318; French (1870) 383; Patterson (1876) 53; Schneck (1876) 575; Brendel (1887) 89; Huett (1897) 132.

Type locality.—Virginia.

Range.—Ont.—Me.—Fla.—N.M.—Colo.; So. Africa.

Rhizome short; leaves tufted, the stipes purplish brown, glossy, the blades linear in outline, 2-4 cm. long, firm, 1-pinnate; pinnae 20-40 pairs, lanceolate, sessile, crenate to incised, auriculate on the upper side near the base; sori 8-12 on each side of the midrib. — Ebony Spleenwort.

Rocky woods, local.

Specimens examined.—ADAMS CO.: Coe Springs, *Evers & Jones 516.* ALEXANDER CO.: McClure, *Pepoon & Barrett 3088* (NHS). CHRISTIAN CO.: Pana, *W. E. Andrews*, July 1915. CLARK CO.: Rocky Branch, *Pepoon & Barrett 5350* (NHS). FAYETTE CO.: Woods near St. Elmo, *Louise Odell 594.* GALLATIN CO.: Shawneetown, *E. J. Palmer 15500* (MBG). JACKSON CO.: Rocky woods, five miles south of Carbondale, *G. N. Jones 11913;* rocky creek bank, one mile north of Makanda, *G. N. Jones 11917;* Makanda, August 19, 1880, *A. B. Seymour; G. Vasey* (no date or number), moist shaded rocks, Grand Tower, *H. A. Gleason*, August 1900. JERSEY CO.: Pere Marquette State Park, *Fuller & Link 106, 572* (SM). JOHNSON CO.: Rich woods at base of rocky bluffs, Tunnel Hill, May 26, 1902, *J. Schneck;* Tunnel Hill, *E. J. Palmer 16684* (MBG); ravine, Benson Bluff, *Mary M. Steagall 14.* LEE CO.: Rocky woods, Franklin Creek, *G. N. Jones 15828.* MACOUPIN CO.: Panther Creek, September 29, 1893, *W. E. Andrews.* MARION CO.: Without locality, *M. S. Bebb* in 1860 (FM). MENARD CO.: New Salem State Park, *G. D. Fuller 3002.* OGLE CO.: Moist woods, White Pines Forest State Park, *E. W. Fell 45544.* PEORIA CO.: Peoria, *Alice J. Heading*, September 1880 (FM). POPE CO.: Golconda, *E. J. Palmer 15441, 15443* (MBG). PULASKI CO.: Chestnut grove, Olmstead, August 29, 1916, *W. Trelease.* SANGAMON CO.: Springfield, *G. D. Fuller 7916* (SM). ST. CLAIR CO.: Bluff Lake, May 17, 1878, *H. Eggert* (MBG).; Centerville, June 25, 1878, *H. Eggert* (MBG); without locality, *F. Brendel* in 1851 (PAS). UNION CO.: Anna, *E. J. Palmer 14852* (MBG), *H. C. Benke 4659* (FM); Cobden, June 16, 1869, *I. S. Rayomnd;* without locality, *F. Brendel* in 1860. WABASH CO.: Mt. Carmel, August 1889, *J. Schneck;* Hanging Rock, October 20, 1882, *J. Schneck.* WHITE CO.: Norris City, *Pepoon & Barrett 5146* (NHS). WILLIAMSON CO.: Grassy Creek, Devils Kitchen, *J. McCree 844, J. McCree & G. Wilson 1270.*

ASPLENIUM RESILIENS Kunze in Linnaea **18**:331 (1844); Britton & Brown (1913) 27.

Asplenium parvulum Mart. & Gal. Nouv. Mém. Acad. Sci. Brux. **15**:60 (1842); Steagall (1927) 115.

Type locality.—Mexico.

Range.—Pa.—Mo.—Kans.—Ariz.—Fla.; Mexico; Jamaica; South America.

Rhizome short, chaffy, the scales stiff, black; leaves tufted, the stipes black, glossy; blades linear-oblanceolate in outline, firm, 5-25 cm. long, pinnate; pinnae mostly opposite, oblong, obtuse, entire or crenulate, 4-12 mm. long, auriculate on the upper side near the nearly sessile base.— Black Spleenwort.

Reported by Dr. Mary M. Steagall (as *A. parvulum*) from Jackson Co.: ". . . found only on the limestone at Bald Knob and near Grand Tower,

growing either in the crevices of the limestone, or on the rich mold covering them." — Steagall (1927) 116. There is, however, no specimen of this fern to be found in Dr. Steagall's collection.

Specimens examined.—JACKSON CO.: Vicinity of Carbondale, *A. F. Whiting 1781* (FM). UNION CO.: Rocky woods and cliffs, east of Wolf Lake, *H. A. Gleason 9024.**

ASPLENIUM TRICHOMANES L. Sp. Pl. 1080 (1753); Lapham (1857) 549; Forbes (1870) 318; French (1870) 383; Patterson (1876) 53; Schneck (1876) 575; Brendel (1887) 89; Hill (1912a) 38; Steagall (1927) 115; Palmer (1936) 138; Jones (1945) 38.

Type locality.—"Habitat in Europae fissuris rupium."

Range.—Que.—Ala.—Ariz.—Alaska; Eurasia.

Rhizome short, ascending; leaves tufted, the stipes glossy, purplish brown, the blades linear in outline, pinnate, evergreen, 5-20 cm. long; pinnae oval, cuneate at the base, slightly crenate; sori 3-6 on each side of the midrib. — Maidenhair Spleenwort.

Sandstone cliffs, southern Illinois, rare.

Hill (1912a) says "Starved Rock, two plants, *Ferriss.*" Specimens of this collection are not available.

Specimens examined.—ALEXANDER CO.: McClure, *E. J. Palmer 14908.* JACKSON CO.: Makanda, *Vasey* (no date or number), August 19, 1880, *A. B. Seymour*, July 18, 1917, *L. P. Cranwill;* Grand Tower, moist shaded rocks, May 5, 1902, *H. A. Gleason*, limestone cliff, May 2, 1897, *F. M. Woodruff;* Fountain Bluff, *G. D. Fuller 156* (FM), *V. H. Chase 6628* (PAS). JOHNSON CO.: Crevices of sandstone, Tunnel Hill, May 26, 1902, *J. Schneck, B. F. Bush 6917* (MBG), *E. J. Palmer 15188* (MBG); Glen Fern, August 30, 1890, *J. Schneck.* POPE CO.: Herod, July 27, 1898, *G. P. Clinton;* Golconda, *E. J. Palmer 17020* (MBG). UNION CO.: Without locality, *F. Brendel* in 1860; Cobden, June 8, 1885, *Earle & Waite;* crevices of sandstone, Granite City, September 21, 1921, *Mary M. Steagall.*

11. ATHYRIUM Roth

Ferns with ascending or horizontal rhizomes; leaves 1-3-pinnate, tufted, not evergreen; veins free; stipes greenish or stramineous, not filiform or wiry; sori dorsal, linear to elliptical, straight or curved; indusium superior, shaped like the sorus, attached laterally, or in some species vestigial or concealed.

1. Leaves bipinnate or bipinnatifid.
   2. Leaves bipinnate; pinnules sharply serrate or incised ..... *A. angustum*
   2. Leaves bipinnatifid; segments crenate-serrate ..... *A. thelypterioides*
1. Leaves 1-pinnate; pinnae entire or crenulate, linear-lanceolate, acuminate ..... *A. pycnocarpum*

ATHYRIUM ANGUSTUM (Willd.) Presl, Rel. Haenk. 1:39 (1825); Butters (1917a) 190; Jones (1945) 38; Fuller (1946) 52.

Aspidium angustum Willd. Sp. Pl. (ed. 4) 5:277 (1810).

Aspidium asplenioides sensu Mead (1846) 120. — Non (Michx.) Sw. (1806).

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* Thanks are due Mr. C. A. Weatherby for kindly checking this specimen in the Gray Herbarium.

Athyrium filix-femina rubellum Gilb., List of N. Am. Pterid. 35 (1901).

Athyrium angustum var. *rubellum* (Gilb.) Butters in Rhodora **19**:193 (1917).

Asplenium filix-femina sensu Lapham (1857) 549; French (1870) 383; Babcock (1873) 98; Patterson (1874) 18, (1876) 53; Schneck (1876) 575; Brendel (1887) 65; Higley & Raddin (1891) 150; Huett (1897) 132; Hill (1912a) 38; Palmer (1921) 134; Thone (1925) 101; Pepoon (1927) 145.—Non *A. filix-femina* (L.) Bernh.

Athyrium filix-femina sensu Hill (1912) 38; Steagall (1927) 115.—Non (L.) Roth.

Type locality.—"Habitat in Canada."

Range.—Newf.—Pa.—Mo.—Colo.—S.D.—Man.

Leaves tufted, deciduous, 30-90 cm. long, lanceolate, widest near the middle, tapering toward the base and apex, bipinnate; stipes straw colored or brownish, chaffy or almost smooth; pinnae lanceolate, 5-12 cm. long; pinnules 4-12 mm. long, obtuse, shallowly toothed; sori linear, straight, contiguous.—Lady Fern.

Woods, locally throughout Illinois.

Specimens examined.—ALEXANDER CO.: Diswood, *Pepoon & Barrett 702, 3617* (NHS). CARROLL CO.: Palisades State Park, Savanna, *G. N. Jones 17295.* COOK CO.: Edgebrook, *F. C. Gates 463* (FM); moist woods, Grand Crossing, July 12, 1875, *E. J. Hill.* DU PAGE CO.: Woods, Winfield, *W. S. Moffatt 421, 884.* FULTON CO.: Canton, *J. Wolf*, no date or number (FM). HENDERSON CO.: Oquawka, *H. N. Patterson*, no number or date (FM). HENRY CO.: Ophiem, July 11, 1944, *G. H. Boewe* (NHS). JACKSON CO.: Fountain Bluff, *V. H. Chase 6643* (PAS). JO DAVIESS CO.: Galena, *O. E. Lansing 4227* (FM). JOHNSON CO.: Goreville, *J. Schopf* in 1931 (NHS). KANE CO.: Sugar Grove, July 9, 1946, *G. H. Boewe* (NHS). KANKAKEE CO.: Moist woods, Rock Creek, July 28, 1873, *E. J. Hill.* KNOX CO.: Wooded hillside, Williamsfield, *V. H. Chase 1832.* LAKE CO.: Antioch, *G. N. Jones 16513;* Beach, *F. C. Gates 3129.* LA SALLE CO.: Starved Rock, *F. Thone 89, A. W. DeSelm 786* (FM). LOGAN CO.: Lincoln, *H. A. Gleason 778.* MACON CO.: Decatur, *I. W. Clokey*, June 1896. MARION CO.: Without locality, *M. S. Bebb* in 1860 (FM). MARSHALL CO.: Wooded hills along the Illinois River, Steuben Tp., *V. H. Chase 1810.* McHENRY CO.: Algonquin, July 21, 1944, *G. H. Boewe* (NHS). MENARD CO.: Athens, *E. Hall* in 1861 (FM). OGLE CO.: Moist woods, Oregon, August 4, 1883 and August 12, 1885, *M. B. Waite.* PEORIA CO.: Peoria, *F. E. McDonald*, August 1882, also *F. Brendel* (no number or date); rich woods, Princeville, June 17, 1898, *V. H. Chase*, fence-corner in clearing, *V. H. Chase 105.* PIATT CO.: Monticello, July 17, 1886, *Seymour & Waite.* PIKE CO.: Valley City, August 28, 1930, *Campbell & Alexopoulos.* POPE CO.: Jackson Hollow, *Mary M. Steagall 11.* PULASKI CO.: Karnak, August 6, 1946, *G. H. Boewe* (NHS). RICHLAND CO.: Olney, *R. Ridgway 119, 127, 128* (FM). SCHUYLER CO.: Wooded bluffs, Sugar Creek, *Evers & Jones 581.* STARK CO.: Rich woods, Essex, July 20, 1892, *Agnes Chase.* TAZEWELL CO.: Without locality, July 1889, *F. E. McDonald.* UNION CO.: Cobden, July 25, 1886, *F. S. Earle.* VERMILION CO.: Stony Creek, June 24, 1880, *Seymour & Butts.* WABASH CO.: Without locality, *J. Schneck*, July 1891. WHITE CO.: Without locality, *Pepoon & Barrett 4688* (NHS). WILL CO.: Joliet, *H. C. Skeels 394* (FM).

ATHYRIUM THELYPTERIOIDES (Michx.) Desv. in Mém. Soc. Linn. Paris 6:266 (1827); Hill (1912a) 38; Fuller (1946) 52.

Asplenium acrostichoides Sw. in Journ. Bot. Schrad. 1800**2**: 54 (1801).

Asplenium thelypterioides Michx. Fl. Bor. Am. **2**:265 (1803); Mead (1846) 121; Lapham (1857) 549; Patterson (1876) 53; Schneck (1876) 575; Brendel (1887) 65; Higley & Raddin (1891) 150; Huett (1897) 132.

Athyrium acrostichoides (Sw.) Diels in Engler & Prantl, Nat. Pflanzenf. **1**2:223

(1899). — Non *Athyrium acrostichoideum* Bory ex Mérat, Fl. Paris (ed. 4) **1**:471 (1836).

Diplazium acrostichoides (Sw.) Butters in Rhodora **19**:178 (1917); Jones (1945) 38.

Type locality.—"Hab. in montibus Virginiae et Carolinae septentrionalis."

Range.—N.S.—Ga.—Kans.—Iowa—Minn.

Rhizome slender, horizontal; stipes stramineous, somewhat chaffy below when young, 20-30 cm. long; blades lanceolate in outline, pinnate-pinnatifid, acuminate, 30-90 cm. long; pinnae linear-lanceolate, sessile, acuminate, pinnatifid, sparingly pilosulous along the midrib on the underside; segments oblong, obtuse, serrate-crenate, each bearing 3-6 pairs of oblong straight or slightly curved sori. — Silvery Glade Fern.

Growing usually in humus in woods, along stream banks and wooded ravines, or on moist slopes, particularly in maple, white oak, or beech woods, locally throughout Illinois.

Specimens examined.—ALEXANDER CO.: Deep moist woods, Thebes, August 1, 1917, *L. P. Cranwill.* BROWN CO.: Wooded ravine, Siloam, *R. A. Evers 1280.* CARROLL CO.: Woods, Palisades State Park, *G. N. Jones 17227.* CASS CO.: Beardstown, *H. S. Pepoon*, no number or date (NHS). CHAMPAIGN CO.: Woods, Urbana, October 2, 1880, *A. B. Seymour.* CLARK CO.: Rocky Branch, June 15, 1933, *H. S. Pepoon* (NHS). FULTON CO.: Canton, *J. Wolf*, no number or date (PAS). HENDERSON CO.: Oquawka, *H. N. Patterson*, no number or date (FM). JACKSON CO.: Along stream in Mill Ravine, Big Hill, *Mary M. Steagall 9.* JO DAVIESS CO.: Low rich woods, Warren, *H. S. Pepoon*, August 1891, also *L. M. Umbach*, July 8, 1896 (FM). KANKAKEE CO.: Kankakee, *Lansing & Sherff 17* (FM), *A. W. DeSelm 731* (FM). LA SALLE CO.: Starved Rock, *G. D. Fuller 1759* (SM). MACOUPIN CO.: Carlinville, July 12, 1893, *W. E. Andrews.* OGLE CO.: White Pines Forest State Park, July 26, 1942, *Alice L. Hills* (SM). PEORIA CO.: Without locality, *F. Brendel*, no number or date; shady ravine, Limestone Tp., *V. H. Chase 6913* (PAS). POPE CO., Equality, *J. Schopf* in 1931 (NHS). TAZEWELL CO.: Damp shady woods, without definite locality, *F. E. McDonald*, August 1889. UNION CO.: Cobden, July 25, 1885, *F. S. Earle;* woods, State Forest, *G. D. Fuller 703.* WABASH CO.: Hanging Rock, July 27, 1880, *J. Schneck;* damp shady bluff, "Little Rock," June 4, 1896, *J. Schneck.* WINNEBAGO CO.: Moist ravine in oak woods, Perryville, *G. D. Fuller 11234.*

ATHYRIUM PYCNOCARPON (Spreng.) Tidestrom, Elys. Marianum **1**:36 (1906); Fuller (1946) 52.

Asplenium pycnocarpon Spreng. Anleit. Kennt. Gew. **3**:112 (1804).

Asplenium angustifolium Michx. Fl. Bor. Am. **2**:265 (1803); Patterson (1874) 18, (1876) 53; Schneck (1876) 575; Brendel (1887) 65; Huett (1897) 132; Pepoon (1909) 36; Hill (1912a) 38; Palmer (1921) 134; Pepoon (1927) 145; Steagall (1927) 115; Palmer (1936) 138. — Non Jacq. (1786).

Diplazium pycnocarpon (Spreng.) Broun, Index N. Am. Ferns 60 (1938); Jones (1942) 71, (1945) 38.

Type locality.—Banks of the Ohio River.

Range.—Que.—Ga.—La.—Kans.—Minn.

Rhizome stout, horizontal; leaves tufted, pinnate, lanceolate in outline, glabrous, 30-60 cm. long; pinnae 20-30 pairs, linear-lanceolate, acuminate, 5-12 cm. long, entire or crenulate; sori linear, crowded, 20-30 on each side of the midrib. — Glade Fern.

Moist woods, locally throughout Illinois.

Specimens examined.—ALEXANDER CO.: Woods, Horseshoe Island, *G. N. Jones 12052.* CHAMPAIGN CO.: Woods, Urbana, June 20, 1879, and October 12, 1880, *A. B. Seymour;* woods, Harrisburg, near Urbana, October 15, 1898, *G. Gibbs;* Brownfield Woods near Urbana, *G. N. Jones 12509, 13651.* FULTON CO.: Canton, *J. Wolf* (SM). HENDERSON CO.: Bald Bluff, September 18, 1871, *H. N. Patterson* (FM). JACKSON CO.: Fountain Bluff, common, July 30, 1917, *L. P. Cranwill;* moist ravine, Leo Rock, near Fountain Bluff, *Mary M. Steagall 10;* Fountain Bluff, *V. H. Chase 6632* (PAS); moist shaded rocks, Grand Tower, May 5, 1902, *H. A. Gleason.* JERSEY CO.: Pere Marquette State Park, *G. M. Link 2042* (SM). JO DAVIESS CO.: Rocky ravine, without definite locality, *Pepoon & Moffatt 215;* moist bluffs, Warren, July 8, 1896, *L. M. Umbach* (PAS). LA SALLE CO.: Starved Rock, *G. D. Fuller 1758* (SM). MARION CO.: Without locality, *M. S. Bebb,* no date or number (FM). McLEAN CO.: Moist woods, occasional, Funks Grove, *G .D. Fuller 7421.* PEORIA CO.: Peoria, *F. Brendel,* July 1860. TAZEWELL CO.: Moist wooded ravine, Spring Creek, *V. H. Chase 4850.* UNION CO.: Woods, Bluff Lake, August 7, 1880, *A. B. Seymour;* Jonesboro, *G. D. Fuller 398* (FM). VERMILION CO.: Danville, June 24, 1886, *M. B. Waite.* WABASH CO.: Hanging Rock, *J. Schneck 111.* WILL CO.: Joliet, *H. F. Monroe,* no number or date (MBG). WOODFORD CO.: Moist ravine north of Spring Bay, *V. H. Chase 6193* (PAS).

12. WOODWARDIA Sm.

Large ferns with uniform leaves; sori oblong or linear in chain-like rows parallel to the midvein; veins united to form a series of narrow areolae along the midrib, elsewhere free; indusium fixed by its outer margin, opening next to the midrib.

WOODWARDIA VIRGINICA (L.) Sm. Mem. Acad. Tor. 5:412 (1793); Hill (1910) 66; Jones (1945) 39.

Blechnum virginicum L. Mant. **2**:307 (1771).

Woodwardia angustifolia sensu Snare & Hicks (1898) 25.—Non Sm. (1793).

Type locality.—Virginia.

Range.—N.S.—Mich.—Mo.—Tex.—Fla.

Rhizome stout, chaffy; leaves lanceolate, acute at the apex, narrowed at the base, 30-60 cm. long; pinnae linear-lanceolate, sessile, acuminate, glabrous, pinnatifid, the segments obtuse, oblong, serrulate; sori 4 mm. long.—Eastern Chain Fern.

Specimens examined.—LAKE CO.: Tamarack bog near Antioch, *G. D. Fuller & G. N. Jones* in 1944 (*G.N.J. 16512*).

13. CRYPTOGRAMMA R. Br.

Small chiefly rupestral ferns with the leaves of two kinds, the sterile ones foliaceous, 1-3-pinnate, the fertile ones taller with fewer and narrower segments; sori marginal, continuous; margins of the pinnules reflexed over the sporangia.

CRYPTOGRAMMA STELLERI (S. G. Gmel.) Prantl in Engler's Bot. Jahrb. 3:413 (1882); Robinson & Fernald (1908) 37; Pepoon (1909) 36, (1927) 144; Jones (1945) 39; Fuller (1946) 52.

Pteris stelleri S.G.Gmel. Nov. Comm. Acad. Sci. Petrop. **12**:519 (1768).

Allosorus gracilis Presl, Tent. Pterid. 153 (1836); Bebb (1860) 183.

Pellaea gracilis (Presl) Hook. Sp. Fil. **2**:138 (1858); Patterson (1876) 53:

Brendel (1887) 89; Huett (1897) 132; Hill (1900) 31, (1902) 82, (1912) 1, (1912a) 37.

Pellaea stelleri (S. G. Gmel.) Watt in Canad. Nat. II. **3**:158 (1866); Hill (1889) 598.

Type locality.—"Siberia."

Range.—Lab.—N.J.—Iowa—Colo.—Utah—Wash.—Alaska. Asia.

Rhizomes slender, horizontal; leaves few, delicate, membranous, bipinnate, 5-20 cm. long, dimorphic, the fertile exceeding the sterile, with lanceolate to linear, acute, undulate-margined segments; sterile blades with ovate to obovate, cuneate, crenately lobed segments; rachis green; stipes slender, usually longer than the blades, stramineous above, chestnut-brown below. — Slender Rock-brake.

On damp, usually calcareous rocks, rare, northern Illinois.

Specimens examined.—CARROLL CO.: Savanna, June 10, 1909, *H. C. Cowles* (SM). COOK CO.: Shaded calcareous rocks, Sag Bridge, June 25, 1909, *E. J. Hill;* Lemont, *E. J. Hill* in 1899. JO DAVIESS CO.: Crevices of limestone, without definite locality, *Pepoon & Moffatt 175;* shaded cliffs, Warren, July 9, 1896, *L. M. Umbach,* also July 1891, *H. S. Pepoon;* Apple River Canyon State Park, *G. N. Jones 15818.* KANKAKEE CO.: Shaded limestone, Bourbonnais, June 13, 1874, *E. J. Hill.* OGLE CO.: Limestone cliff in pine woods, without definite locality, *Mary M. Steagall 20;* shaded limestone rocks, Oregon, July 22, 1883, and August 12, 1884, *M. B. Waite;* moist rocks, Oregon, July 17, 1885, *M. B. Waite;* moist shaded sandstone cliff, Liberty Hill, Oregon, July 10, 1905, *E. J. Hill.* ROCK ISLAND CO.: Port Byron, June 21, 1892, *E. T. Harper* (FM). WILL CO.: limestone ledge, Lockport, *Agnes Chase 1109;* ravine, Joliet, *E. J. Hill* in 1899. WINNEBAGO CO.: Rockford, Limestone cliffs, rare, *G. D. Fuller 10136;* Roscoe, May 30, 1945, *E. W. Fell* (SM).

14. PELLAEA Link—Cliff-brake

Small or medium-sized rupestral ferns with pinnate or pinnatifid uniform leaves; veins free; sori intramarginal; indusium commonly broad, formed by the reflexed margins of the fertile segments.

1. Stipes and rachises glabrous or nearly so; leaves 5-25 cm. long, pale bluish green ..... *P. glabella*

1. Stipes and rachises with numerous jointed hairs; leaves 10-50 cm. long, grayish green ..... *P. atropurpurea*

PELLAEA GLABELLA Mett. ex Kuhn in Linnaea **36**:87 (1869); Pickett (1914) 97-101, (1917) 3-5; Butters (1917b) 77, (1922) 75; Jones (1945) 39; Fuller (1946) 52.

Pellaea atropurpurea sensu Vasey (1861) 143; Patterson (1874) 18; Brendel (1887) 89; Hill (1899) 308, 596, (1902) 82; Pepoon (1909) 34; Hill (1912) 37; Thone (1925) 101; Pepoon (1927) 144. — Non (L.) Link.

Type locality.—"America borealis, Kimmswick prope St. Louis, . . ."

Range.—Vt.—Minn.—B.C.—Colo.—Okla.—Tenn.

Leaves 5-25 cm. long; stipe and rachis reddish brown, glossy, glabrous or with a few speading hairs, the scales at the base of the stipe with a few prominent teeth. — Smooth Cliff-brake.

Chiefly calcareous rocks, local.

Specimens examined.—ADAMS CO.: Abundant on rocky cliffs of Fall Creek Gorge,

Evers & Jones 671; limestone outcrop, Fall Creek, *R. A. Evers 54.* CARROLL CO.: Limestone cliff, Savanna, *Agnes Chase 1881;* dry cliffs, October 5, 1887, *M. B. Waite;* calcareous rocks, July 12, 1902, *E. J. Hill;* Palisades State Park, *V. H. Chase 5362* (PAS). COOK CO.: Limestone cliff, Lemont, September 5, 1898, June 29, 1898, *E. J. Hill;* face of limestone bluff, Lemont, June 29, 1899, *E. J. Hill;* limestone cliffs, Lemont, October 25, 1897, *E. J. Hill;* dry limestone rocks, Sag Bridge, October 13, 1908, *E. J. Hill.* HENDERSON CO.: Oquawka, *H. N. Patterson* (no number or date). JERSEY CO.: Pere Marquette State Park, *Fuller & Link 27* (SM). JO DAVIESS CO.: Clefts of rock, Hanover, *C. N. Jones 17272;* crevices of rocks, without definite locality, *Pepoon & Moffatt 181;* Warren, July 8, 1896, *L. M. Umbach* (PAS); Galena, *W. B. McDougall 210, F. Brendel* (no number or date). KANKAKEE CO.: Dry calcareous rocks, Rock Creek, June 24, 1871, *E. J. Hill;* limestone crevices near Rockville, *C. N. Jones 13527.* LA SALLE CO.: Without definite locality, September 6, 1877, *G. Engelmann* (MBG). MADISON CO.: Cahokia, *G. Engelmann,* September 1844 (MBG). OGLE CO.: Sand rock, Oregon, August 22, 1884, *M. B. Waite;* Liberty Hill, *C. N. Jones 16378;* rocky bank of Rock River, August 26, 1891, *Mrs. C. M. Winston;* Foreston, August 26, 1891, *Mrs. C. M. Winston;* dry sandstone cliff, Rock River, July 12, 1905, *E. J. Hill.* POPE CO.: Herod, July 29, 1898, *G. P. Clinton.* ST CLAIR CO.: Without locality, *F. Brendel* in 1851 (PAS). STEPHENSON CO.: Baileyville, November 3, 1945, *E. W. Fell* (SM). WILL CO.: Limestone cliff, Lockport, June 14, 1899, *E. J. Hill;* limestone ledge, Lockport, May 24, 1899, *E. J. Hill, Agnes Chase 1076;* Lockport, *Agnes Chase 1110.* WINNEBAGO CO.: Roscoe, October 11, 1945, *E. W. Fell* (SM); Rockford, *G. D. Fuller 10148* (SM).

PELLAEA ATROPURPUREA (L.) Link, Fil. Hort. Berol. 59 (1841); Patterson (1876) 53, ex p.; Schneck (1876) 575; Brendel (1887) 89; Butters (1917b) 78; Palmer (1936) 138; Jones (1945) 39.

Pteris atropurpurea L. Sp. Pl. 1076 (1753).

Allosorus atropurpureus (L.) Kunze ex Presl, Tent. Pterid. 153 (1836); Lapham (1857) 549.

Type locality.—Virginia.

Range.—Me.—Ga.—Ariz.—S.D.

Leaves 10-50 cm. long; stipe and rachis dark purplish brown, usually dull, rather copiously pubescent with more or less appressed hairs, the scales at the base of the stipe entire, or only obscurely toothed. — Purple Cliff-brake.

Calcareous rocks, not common.

Specimens examined.—ALEXANDER CO.: McClure, *E. J. Palmer 16621* (MBG). GALLATIN CO.: Cave-in-Rock, *J. Schopf* in 1931 (NHS). HARDIN CO.: Peters Creek, *E. J. Palmer 15463* (MBG). JACKSON CO.: Grand Tower, *G. D. Fuller 11594* (SM). ST. CLAIR CO.: Without definite locality, *F. Brendel* in 1851. UNION CO.: Limestone cliff, Wolf Lake, *Mary M. Steagall 28;* Cobden, June 16, 1869, *I. S. Raymond.* WABASH CO.: Hanging Rock, *J. Schneck 121.*

15. ADIANTUM L.—Maidenhair Fern

Slender ferns with creeping rhizomes, compound leaves with dark colored glossy stipes, and the marginal sori borne on the underside of reflexed lobes of the pinnules or segments.

ADIANTUM PEDATUM L. Sp. Pl. 1095 (1753); Lapham (1857) 549; French (1870) 383; Babcock (1873) 98; Patterson (1874) 18, (1876) 53; Schneck (1876) 574; Brendel (1887) 65; Higley & Raddin (1891) 149; Huett (1897) 131; Snare & Hicks (1898) 25; Hill (1912a) 37; Palmer

(1921) 134; Gates (1922) 165; Thone (1925) 101; Gates (1925) 226; Pepoon (1927) 143; Steagall (1927) 115; Stover (1930) 25; Fuller (1943) 91; Jones (1945) 39; Fuller (1946) 52.

Type locality.—"Habitat in Canada, Virginia."

Range.—Newf—Ga.—Utah—Calif.—Alaska.

Leaves roundish in outline, 15-50 cm. broad, delicate; stipe dark brown to nearly black, slender, rigid, forked at the summit; pinnae pedately arranged; pinnules deltoid-oblong, crowded, the lower margin entire, the upper unevenly toothed or cleft; sori linear or lunate.

Common throughout Illinois in rich woods.

Specimens examined.—ADAMS CO.: Woods, Coe Springs, *Evers & Jones 505;* moist woods, Zion Church, *Evers 105.* ALEXANDER CO.: Horseshoe Island *G.N. Jones 12047.* CALHOUN CO.: Hardin, August 26, 1930, *Campbell & Alexopoulos* (NHS). CARROLL CO.: Wooded hillside, Savanna, *Agnes Chase 1878.* CHAMPAIGN CO.: Woods, Urbana, January 17, 1880, *Seymour & Butts;* woods, Mahomet, September 6, 1899, *G. P. Clinton,* October 8, 1898, *H. A. Gleason.* CHRISTIAN CO.: Rich moist woods, Taylorville, June 4, 1897, *Ruby DeMotte.* CLARK CO.: Woods, Rocky Branch, *G. N. Jones 12608.* COLES CO.: Fox Ridge State Park, *G. N. Jones 10681, 10686;* Charleston, *G. N. Jones 17455.* COOK CO.: Rich woods, Grand Crossing, July 12, 1875, *E. J. Hill;* damp woods, Evanston, June 5, 1889, *L. N. Johnson.* DU PAGE CO.: Woods, Winfield, *W. S. Moffatt 881.* EFFINGHAM CO.: Effingham, *Pepoon & Barrett 5510* (NHS). FAYETTE CO.: Ramsey, *Louise Odell 1.* FULTON CO.: Canton, *J. Wolf* (SM). HANCOCK CO.: Woods, Rock Creek, *F. C. Gates 10130;* Carthage, *Kirchherr & Fuller 45* (SM). HARDIN CO.: Cave-in-Rock, April 28, 1928, *C. J. Telford* (NHS). HENDERSON CO.: Oquawka, *H. N. Patterson* (without date or number). HENRY CO.: Cleveland, September 10, 1943, *L. R. Tehon* (NHS). JACKSON CO.: Fountain Bluff, *V. H. Chase 6637* (PAS). JERSEY CO.: Pere Marquette State Park, *Fuller & Link 113* (SM). JOHNSON CO.: Rich woods, Tunnel Hill, May 26, 1902, *J. Schneck,* KANKAKEE CO.: Kankakee, May 31, 1873, *E. J. Hill.* KNOX CO.: Wooded hillside, Williamsfield, *V. H. Chase 1833.* LAKE CO.: Beach, *F. C. Gates 3127.* LA SALLE CO.: Starved Rock, *F. Thone 25; Deer Park, E. C. Piatt,* September 1880. LEE CO.: Franklin Grove, *E. Keithley 145* (SM). MARSHALL CO.: Wooded hills along the Illinois River, Steuben Tp., *V. H. Chase 1812.* McHENRY CO.: Algonquin, September 17, 1878, *W. A. Nason.* MENARD CO.: New Salem State Park, *G. D. Fuller 3000* (SM). OGLE CO.: Rich moist woods, Oregon, July 28, 1883, *M. B. Waite, W. S. Moffatt 470.* PEORIA CO.: Moist bank of shady ravine, Princeville, *V. H. Chase 74;* woods, abundant, Peoria, *F. E. McDonald,* July 1890. PIKE CO.: Kinderhook, June 28, 1934, *G. H. Boewe* (NHS). POPE CO.: Herod, July 29, 1898, *G. P. Clinton;* Golconda, *E. J. Palmer 15442* (MBG). PULASKI CO.: Chestnut grove, Olmstead, August 29, 1916, *W. Trelease;* Villa Ridge, June 14, 1869, *I. S. Raymond.* SCHUYLER CO.: Wooded bluffs, Sugar Creek, *Evers & Jones 545.* STARK CO.: Hillside in rich woods, Spoon River, June 10, 1892, *Agnes Chase.* UNION CO.: Wooded slope, Bald Knob, October 6, 1922, *Mary M. Steagall;* moist woods, common, Pine Hills, *G. D. Fuller 765;* rich woods, State Forest, *G. D. Fuller 701.* VERMILION CO.: Danville, June 24, 1886, *M. W. Waite;* near Oakwood, *G. N. Jones 11312.* WINNEBAGO CO.: Moist woods, common, Roscoe, *E. W. Fell 45346;* Rockford, *Fuller & Haime,* July 25, 1940 (SM).

16. CHEILANTHES Sw.—Lip Fern

Chiefly rupestral small ferns with compound leaves; sterile and fertile leaves nearly alike; indusium formed of the reflexed margin of the leaf; sori marginal, borne at or near the tips of the veins, often more or less concealed by the pubescence of the leaf.

1. Leaves 3-10 cm. long, 1-2 cm. wide, densely tomentose beneath; stipes becoming nearly or quite glabrous; indusia continuous ..... *C. feei*
1. Leaves 10-30 cm. long, 2-6 cm. wide, hirsute-villosulous beneath; stipes persistently hirsute; indusia discontinuous ..... *C. lanosa*

CHEILANTHES FEEI Moore, Index Fil. xxxviii (1857); Gleason (1903) 2; Robinson & Fernald (1908) 36; Hill (1912a) 37; Maxon (1913) 34; Steagall (1927) 115; Rydberg (1932) 15; Jones (1945) 39; Fuller (1946) 52.

Cheilanthes lanuginosa Nutt. ex Hook. Sp. Fil. **2**:99 (1858), pro syn.; Hook. & Bak. Syn. Fil. 139 (1868). — Non Mart. & Gal. (1842); Patterson (1876) 53; Brendel (1887) 89.

Type locality.—"Habitat ad rupes circa Hillsboro [Missouri], in America septentr."

Range.—B.C.—Minn.—Ill.—Ark.—Ariz.; Mexico.

Rhizome short, scaly; leaves evergreen, tufted, 3-10 cm. long, 2-3-pinnate, the lower surface densely tomentose; ultimate segments roundish; stipes slender, nearly as long as the blades, pubescent at first, soon becoming glabrous. — Slender Lip Fern.

Among rocks, principally limestone, not common; chiefly in the western and southern parts of the state.

Specimens examined.—CALHOUN CO.: Kampsville, *L. M. Turner 40* (FM.) Savanna, limestone bluffs, rare, May 20, 1909, *H. C. Cowles, G. N. Jones 16362;* pockets in dry limestone cliff, Savanna, *Agnes Chase 1882;* calcareous rocks, Savanna, July 12, 1902, *E. J. Hill;* dry cliffs, Savanna, October 3, 1887, *M. B. Waite;* west face of dolomite, Savanna, *Mary M. Steagall 18.* GREENE CO.: Eldred, May 11, 1891, *W. E. Andrews.* JACKSON CO.: Crevices of rocks, Grand Tower, November 5, 1881, *French & Seymour;* dry cliffs of Devonian limestone, Grand Tower, May 2, 1902, *H. A. Gleason.* JERSEY CO.: Rocks, frequent, Grafton, October 1882, *A. B. Seymour;* vertical cliffs of limestone, rather plentiful locally, Pere Marquette State Park, *G. D. Fuller 10000;* Elsah, May 18, 1918, *R. Hoffmann.* JO DAVIESS CO.: Galena, June 1853, *F. Brendel;* limestone cliffs, Hanover, *Gleason & Gates 2585.* UNION CO.: Big Muddy, *Pepoon & Barrett 3573* (NHS); Pine Hill, *G. D. Fuller 263* (NHS).

CHEILANTHES LANOSA (Michx.) D. C. Eaton in Torr. Rep. U. S. & Mex. Bound. Surv. **2**:234 (1859); Hill (1912a) 37; Deam (1914) 113; Steagall (1927) 115; Palmer (1936) 138; Jones (1945) 39.

Nephrodium lanosum Michx. Fl. Bor. Am. **2**:270 (1803).

Adiantum vestitum Spreng. Anleit. Kennt. Gew. **3**:122 (1804).

Cheilanthes vestita (Spreng.) Sw. Syn. Fil. 128 (1806); Mead (1846) 121; Lapham (1857) 549; Forbes (1870) 318; Patterson (1876) 53; Schneck (1876) 574; Brendel (1887) 89.

Cheilanthes tomentosa sensu Vasey (1861) 143. — Non Link (1873).

Type locality.—"Hab. in montibus saxosis Tennassée et Carolinae septentrionalis."

Range.—Conn.—Mo.—Tex.—Ga.

Rhizome short, scaly; leaves evergreen, tufted, 10-30 cm. long, lanceolate in outline, 2-3-pinnate, hirsute beneath; stipes slender, wiry, chestnut brown, hirsute, shorter than the blades.—Hairy Lip Fern.

Chiefly on non-calcareous rocks in the southern part of the state.

Specimens examined.—ALEXANDER CO.: McClure, *E. J. Palmer 16622* (MBG).

GALLATIN CO.: Shawneetown, *E. J. Palmer 15265* (MBG). JACKSON CO.: Sandstone bluff, Giant City, *Mary M. Steagall 19;* dry rocks, Makanda, *G. Vasey* in 1862 (FM), August 19, 1880, *A. B. Seymour.* JOHNSON CO.: Cliffs, Tunnel Hill, *B. F. Bush 6921* (MBG), *E. J. Palmer 15165* (MBG), May 26, 1902, *J. Schneck.* POPE CO.: Golconda, *E. J. Palmer 15395* (MBG); Herod, July 27, 1898, *G. P. Clinton;* Thackers Gap, *G. P. Clinton* in 1898. RICHLAND CO.: Without locality, *R. Ridgway 500* (FM). ST. CLAIR CO.: Without locality, *F. Brendel* in 1851. SALINE CO.: Stonefort, *W. B. Ridgway 119.* UNION CO.: Cobden, July 25, 1886, *F. S. Earle;* rocky soil, Pine Hill, *G. D. Fuller 772;* crevices of rock under pine trees, Pine Hill near Wolf Lake, *G. N. Jones 12083;* Alto Pass, *E. J. Palmer 15018* (MBG).

17. PTERIDIUM Gled. ex Scop.

Large coarse ferns with compound leaves and creeping rhizomes without scales; stipes with numerous vascular bundles; blades pinnately divided, the segments numerous; sori borne along the reflexed margins of the leaf-segments, the true indusium inconspicuous.

PTERIDIUM LATIUSCULUM (Desv.) Hieron. ex R.E. Fries, Wiss. Ergebn. Schwed. Rhod.-Kongo Exped. **1**:7 (1914); Deam (1940) 57; Jones (1945) 37.

Pteris latiuscula Desv. Mém. Soc. Linn. Paris **6**:303 (1827).

Pteris aquilina sensu Mead (1846) 121; Lapham (1857) 549; Bebb (1860) 183; French (1870) 383; Babcock (1873) 98; Patterson (1874) 18, (1876) 53; Schneck (1876) 574; Brendel (1887) 65; Higley & Raddin (1891) 149; Huett (1897) 131; Gleason (1910) 146; Gates (1912) 165; Hill (1912a) 37; Gates (1922) 165; Thone (1925) 101; Pepoon (1927) 144; Steagall (1927) 115. — Non L. (1753).

Pteridium aquilinum sensu Gleason (1907) 181; Fuller (1946) 52. — Non Kuhn (1879).

Pteridium aquilinum var. *latiusculum* (Desv.) Underw. ex Heller, Cat. N. Am. Pl. (ed. 3) 17 (1909); Tryon in Rhodora **43**:47 (1941).

Type locality.—Newfoundland and St. Pierre.

Range.—Newf.—Minn.—S.D.—Wyo.—Colo.—Miss.—N.C.

Rhizomes stout, horizontal, blackish, not scaly, the growing tip glabrous or nearly so; leaves large, coarse, broadly triangular, ternately bipinnate, 30-100 cm. long; pinnules usually at an oblique angle to the costae; ultimate segments glabrous, or slightly pubescent beneath only along the midvein and margins; indusia glabrous. — Eastern Bracken.

In open woods, pastures, and thickets, locally abundant throughout Illinois.

Specimens examined.—ADAMS CO.: Woods, Fall Creek, June 28, 1887, *A. B. Seymour.* CALHOUN CO.: Hardin, August 26, 1930, *Campbell & Alexopoulos* (NHS). CHAMPAIGN CO.: Mahomet, July 31, 1884, *Seymour & Waite.* COOK CO.: Sandy woods, Chicago, *F. E. McDonald,* June 1891; Rogers Park, June 15, 1896, *Agnes Chase;* Forest Glen, *W. S. Moffatt 880, 883.* DU PAGE CO.: Naperville, June 15, 1895, *L. M. Umbach* (FM). FULTON CO.: Canton, *J. Wolf* (SM). HENRY CO.: Without definite locality, May 15, 1938, *R. J. Dobbs* (NHS). JACKSON CO.: Goodbred Hollow, *Mary M. Steagall 36.* JERSEY CO.: Pere Marquette State Park, *Fuller & Link 114* (SM). JO DAVIESS CO.: Apple River Canyon State Park, *G. D. Fuller 6978* (SM). KANKAKEE CO.: Thickets, common, Waldron, July 10, 1873, *E. J. Hill;* open woods, Saint Anne, *G. N. Jones 11412, 11436, 11522.* KNOX CO.: Galesburg, October 5, 1889, *W. E. Andrews.* LAKE CO.: Margin of tamarack swamp, Lake Villa, *Gleason & Shobe 258.* LA SALLE CO.: Starved Rock, *F. Thone 78, Agnes Chase 1586,* July 13, 1901, *E. J. Hill, O. E. Lansing 3786* (FM). MASON CO.: Black Jack oak association, Kil-

bourne, August 14, 1903, *H. A. Gleason.* MENARD CO.: Athens, *E. Hall* in 1861 (FM). OGLE CO.: Oregon, *E. Keithley 158* (SM); Castle Rock, July 21, 1945, *E. W. Fell* (SM). PEORIA CO.: Peoria, *F. Brendel* (no number or date); wooded hill, Gilfillan Creek, Hallock Tp., *V. H. Chase 1768.* STEPHENSON CO.: *Eleroy*, July 25, 1940, *G. H. Boewe* (NHS). TAZEWELL CO.: Dry roadside east of Tremont, *V. H. Chase 6933.* UNION CO.: Pine Hill near Wolf Lake, *G. N. Jones 12082;* Cobden, July 25, 1886, *F. S. Earle;* woods, Cobden, August 18, 1880, *A. B Seymour.* VERMILION CO.: Stony Creek, June 24, 1880, *Seymour & Butts.* WABASH CO.: Mt. Carmel, August 4, 1887, *M. B. Waite*, also *H. Shearer 61.* WILL CO.: Joliet, *H. C. Skeels 549* (FM). WINNEBAGO CO.: Rockford, *Fuller & Haime*, July 25, 1940 (SM).

[*Pteris cretica* L. is reported by J. Schneck in the vicinity of Mt. Carmel. Dr. Schneck says (1900) 201: "About five years ago I first found it growing in my well, where it has continued to thrive ever since. Below about three feet from the surface it remains green throughout the year, and is now (February 15, 1900) thrifty and in all stages of development from mature fruiting speciments down to small plantlets. Last summer I found it in a second well; and today it was shown me in a third. In each instance I learn that the plant has been cultivated in the adjoining house, whence the spores have probably found their way to the wells." Apparently this tropical species has not been recently collected so far north. The following specimen is in the herbarium of the University of Illinois: WABASH CO.: Mt. Carmel, April 15, 1902, *J. Schneck.*]

9. MARSILEACEAE R. Br.

Plants perennial with slender rhizomes and filiform or 4-foliolate long-petioled leaves; sporocarps on peduncles arising from the rhizome near the base of the leaves, containing both megaspores and microspores.

1. MARSILEA L.

Plants with slender-petioled, 4-foliolate leaves; sporocarps ovoid or ellipsoid, with 2 basal teeth, splitting into two valves at maturity.

MARSILEA QUADRIFOLIA L. Sp. Pl. 1099 (1753); Muenscher (1944) 348; Jones (1945) 39.

Type locality—"Habitat in Indiae, Sibiriae, Galliae, Alsatiae fossis."

Range—Mass.—Md.—Tenn.—Ill.; Eurasia.

Rhizomes slender; leaves quadrifoliolate, clover-like, the leaflets obovate, entire, glabrous; sporocarps usually 2 or 3 on a short peduncle attached to the base of a petiole.—European Marsilea.

In ponds, etc., introduced from eastern United States; native of Europe.

Specimens examined.—VERMILION CO.: In pond, Kickapoo State Park, along Vermilion River near Oakwood, *J. T. Buchholz*, October 1939, *G. N. Jones 13052.*

10. SALVINIACEAE Reichenb.

Plants aquatic, free-floating, not attached to the substratum by roots, and bearing small apparently 2-ranked leaves; sporocarps in pairs beneath the stem, soft, thin-walled, unilocular, containing either megaspores or microspores.

1. AZOLLA L.

Plants somewhat moss-like in appearance, with roots on the underside; leaves minute, 2-lobed, imbricate, covering the stem; sporocarps of two kinds, the smaller containing a solitary megaspore, the larger one containing many microsporangia.

AZOLLA MEXICANA Presl, Abh. Boehm. Ges. Wiss. V. **3**:150 (1845); Svenson (1944) 81; Jones (1945) 39.

Azolla caroliniana sensu Lapham (1857) 550; Patterson (1874) 18 (1876) 54; Schneck (1877) 83; Brendel (1887) 65; Higley & Raddin (1891) 152; Huett (1897) 152; Hill (1912a) 41; Fuller (1943) 91; Muenscher (1944) 351. — Non Willd. (1810)

Type locality—Mexico.

Range—Wisc.—Ind.—Mo.—Calif.—B. C.; Mexico; also in trop Am.

Plants greenish or reddish, pinnately branched, 1-2.5 cm. long; leaves deeply 2-lobed, 2-4 mm. long; sporocarps globose, formed from the ventral lobes of the lowest leaves.

Floating on still water, not common.

Higley & Raddin report this plant to occur "In a pond near South Chicago, 1886. During improvements made in this locality, the pond was filled. So far as known, this is the only locality where this species has been found within our limits."

Specimens examined.—ADAMS CO.: *R. A. Evers 144.* CARROLL CO.: Savanna, October 7, 1887, *M. B. Waite* (MBG). FULTON CO.: Copperas Creek, *F. Brendel* (no number or date). HANCOCK CO.: Niota, August 30, 1936, *Alice L. Kibbe* (NHS). HENDERSON CO.: Oquawka, *H. N. Patterson* (no number or date). JACKSON CO.: Elkville, *Fuller & Welch 563* (SM). JERSEY CO.: Pere Marquette State Park, *G. D. Fuller 142* (SM). MASON CO.: Havana, November 20, 1894, *T. J. Burrill & G. P. Clinton.* PEORIA CO.: Peoria, *F. Brendel* in 1852 (PAS); Illinois River, *F. E. McDonald*, August 1893. UNION CO.: Jonesboro, August 22, 1862, *G. Vasey.*

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New Species, Records and Faunistic Notes Concerning Orthoptera in Arizona

Ernest R. Tinkham

The present author, having spent the major portion of the period from 1938 to 1942 in Arizona, was privileged to devote the greater part of several summers in surveying the hot deserts in this state. In addition, special collecting trips were made to remote places which in certain mountain ranges were characterized by extreme xeric conditions. Several interesting forms, which constitute the basis of the present paper, were discovered and among these are 1) two new species, 2) two recently described (Tinkham 1944) subspecies of the Decticinae, 3) two species of Acrididae new to North America north of Mexico, and 4) a number of known species from adjacent states which can now be added to the Arizona list. The addition of new species, subspecies, and records for Arizona and the United States, brings the total number of valid species and subspecies or races for Arizona to 292. It is hoped that eventually this number can be raised to 300.

New Species

Acrididae: Oedipodinae

Trimerotropis arizonensis n. sp.

Pl. 1, Figs. 7, 8; Pl. 4, Fig. 1

This new species, apparently a member of the *caeruleipennis* group of the genus, is faunistically, biologically and taxonomically distinct from *T. cyaneipennis* Bruner, which appears to be its nearest relative and also from *T. caeruleipennis* Bruner, the other member of the group. It appears to possess one feature resembling *T. sparsa* (Thomas) of another group in the form of the vertex but in tegminal and wing characteristics it appears to be closer to *T. cyaneipennis* than to *T. sparsa*.

Despite the apparent need for revision in certain groups of the genus *Trimerotropis* Stal, taxonomically and faunistically the species appears sufficiently distinct to warrant its description as new at this time.

Type—♂, Western slopes of Black mountains several miles east of the Colorado River and about twenty miles below Boulder Dam, Oct. 20, 1939 (E. R. Tinkham; on small knoll in arroyo valley). Measurements in millimeters: head 2.9; pronotum 3.4 long x 3.3 wide and 2.7 deep; tegmen 20.2 x 3.3; wing 17.5 x 11.0 max. breadth; caudal femora 9.8; body 17.5; body length to apices of closed tegmina 25.2; length to apex of caudal femur 19.0 mms.; antennae about 7.0 mms. Type in the Tinkham Collection.

Comparison—Most closely resembling *T. cyaneipennis* from which it is distinguished by the following features: smaller size, more acutely pointed

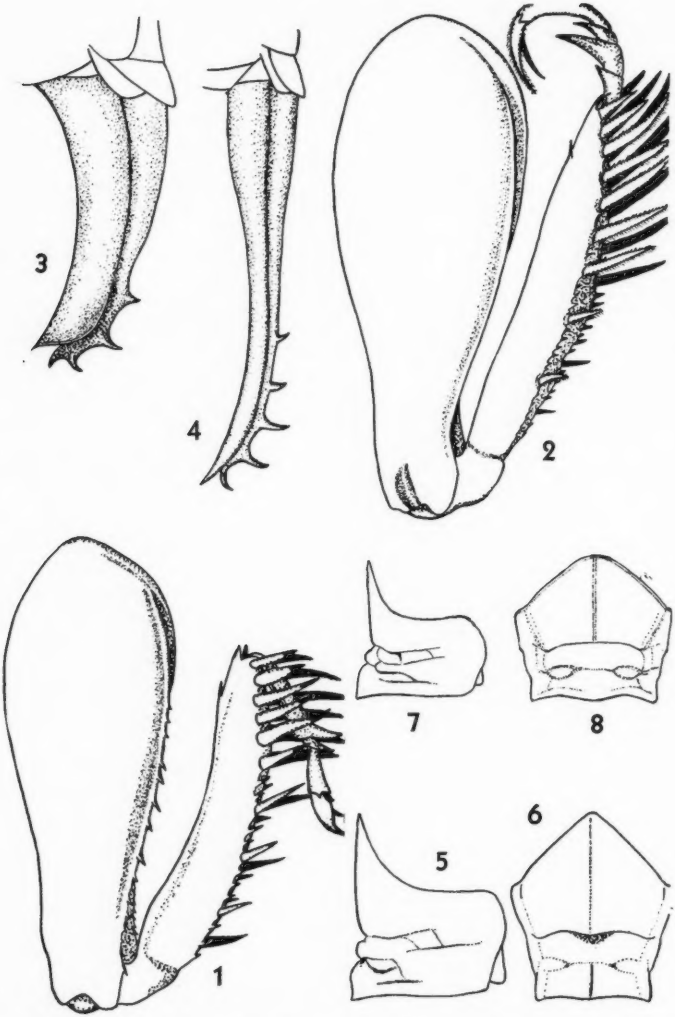

PLATE 1.—Figs. 1-8: 1. Right hind leg of *Ammobaenetes arizonensis* n. sp.; 2. Right hind leg of *Ammobaenetes phrixocnemoides* Caudell; 3. Ovipositor of *Ammobaenetes arizonensis* n. sp.; 4. Ovipositor of *Ammobaenetes phrixocnemoides;* 5. Lateral aspect of pronotum of *Trimerotropis cyaneipennis* from Hualpai Mts. (Arizona); 6. Dorsal aspect of same; 7. Lateral view of pronotum of *Trimerotropis arizonensis* n. sp.; 8. Dorsal view of same.

fastigium of the vertex, and in this latter feature it more closely resembles *T. sparsa;* shorter pronotum with the posterior angle of the plane of the pronotum obtusely rounded and not sharply angular as in *T. cyaneipennis* or *T. sparsa;* principal sulcus of the pronotum cutting the median line just cephalad of center and not in cephalad 2/5 as in *cyaneipennis* and *sparsa.* Eyes slightly more approximate and more globuse than in *cyaneipennis* and to a less marked degree from that observed in *sparsa.* Disc of the wing, green and not bluish as in northern Arizona and Utah specimens of *cyaneipennis* or Great Basin specimens of *sparsa* nor bluish green as in southern Arizona specimens of *cyaneipennis.*

Description—Eyes prominent, large and separated by a space 2/3 the dorsal breadth of an eye. Fastigium of the vertex angularly pointed with the apex rounded and without trace of a median carina or line. Dorsal length of the head unusual in that it is practically equal to the length of the pronotum and not much shorter than the pronotum as in most species of the genus. Pronotum with the prozona weakly bilobate, the posterior hump shorter and lower than the anterior, with smaller humps laterad of the posterior hump (Pl. 1, figs. 7, 8) which are not observed in *cyaneipennis* (Pl. 1, figs. 5, 6). Metazona low and flat in profile (Pl. 1, fig. 7) with a slight trace of a median carina or line. Posterior angle of the dorsal plane of the metazona very obtusely rounded and not angular as in *cyaneipennis* or *sparsa* (Pl. 1, figs. 5-8). Lateral lobes of the pronotum deeper than broad, their greatest depth in the center with the lower or inferior margin more strongly and evenly convex than observed in *cyaneipennis.* Tegmen with the basal or humeral band oblique and irregularly narrow and composed of three blotches of fused annuli more or less united to form the band; area between the band and the base with spots and annuli sparsely filling the space. Second or median band transverse and slightly broader, almost uniformly solid with irregular margins, the humeral and median bands approximate on the posterior margin of the tegmina, the humeral separated from the median on the fore margin by the breadth of the latter. Beyond the median band the apical half of the tegmen is incompletely filled by scattered small patches composed of fused groups of several annuli. The tegmen more closely approximates that observed in *cyaneipennis* than in *sparsa* in which the annuli are separate and never fused into more or less irregularly edged bands. Wing with the disc greenish, the band almost centrally placed with the taenia short and blunt and poorly defined. Band not uniformly black, the heaviest infuscations contiguous to the network of veins in the band. Apical portions of the wing beyond the band transparent, with the veins not as clearly defined as in *sparsa* or *cyaneipennis,* nor infumate as in southern Arizona specimens of *cyaneipennis.* Caudal femora bifasciate on the upper keel and the outer pagina with the genicular areas dark. The caudal tibiae are greenish like the disc of the wing.

Habitat—*Trimerotropis arizonensis* Tinkham, was found on a small gravelly knoll in a steeply sloping arroyo valley or wash on the western slopes of the barren Black Mountains in the extreme northwestern corner of Arizona within two to three miles of the Colorado River. The vegeta-

tion on the knoll was composed of plants peculiar to this region and was composed chiefly of *Franseria dumosa, Coleogyne* and others.

Flora of the Black Mountains—The vegetation of these xeric mountains is made up of microphyllous xerophytes that characterize this section as part of the Nevada subtype of the Sonoran Desert. This area with its few plant types is floristically as well as faunistically distinct from the Sonoran Desert areas proper as found south of Kingman and the Hualpai Mountains. Plant life in the Black Mountains is stunted and sparse with *Franseria dumosa* dominant, and *Coleogyne ramosissima* and *Krameria spinosa* subdominant. Scattered plants of Creosote bush *Larrea divaricata, Thamnosma montana, Eriogonum fasciculatum* and a few rarer plants were found on the hillsides while *Hymenoclea salsola* was dominant in the arroyo valley. Occasional plants of *Yucca mohavensis* were seen on the hillsides. Miners working a shaft in this arroyo valley stated that rattlesnakes, panthers and deer were absent in these barren mountains.

Orthopteran Associates—The only other orthopterans found included a few nymphs of *Tanaocerus koebeli* active at night on *Hymenoclea salsola* in the arroyos, and a few adults of *Poecilotettix sanguineus*. Night collecting revealed no Decticidae or Tettigoniidae. It is evident that the orthopteran fauna of this range is very impoverished.

Faunistics—*T. arizonensis* Tinkham, appears to be a representative species of the Nevada Desert, a subtype of the Sonoran Desert, which is found in the northwestern corner of Arizona, southwestern corner of Utah, southern Nevada and adjacent areas of California including Death Valley. Additional species of the orthopteran fauna of this area include: *Derotmema delicatulum, Arethaea brevicauda, Capnobotes occidentalis, Leprus glaucipennis,* a list as impoverished as the flora.

GRYLLACRIDIDAE: RHAPHIDOPHORINAE

AMMOBAENTES Hubbell, 1936

Hubbell characterized this new genus in his "Monographic Revision of the Genus *Ceuthophilus*" in 1936 and designated *Daihinia phrixocnemoides* Caudell, 1907, as the genotype. The chief diagnostic feature of *Ammobaenetes* is the fact that the long caudal tibial spines have been crowded apically to form a sort of basket of spines for purchase in the loose sands of its environment. From this characteristic it derives its name *Ammobaenetes* which is Greek for "Sand Treader." No additional species of this genus have been described to date.

Ammobaenetes arizonensis n. sp.

Pl. 1, Figs. 1, 3; Pl. 2, Figs. 1, 2

Similar in size to *Ammobaenetes phrixocnemoides* (Caudell), the genotype (from New Mexico, probably the White Sands) but differs strikingly from this species by the much shorter and stouter ovipositor provided with four,

instead of five, ventral apical teeth and also by the spination of the caudal femora which have both inferior keels armed with numerous small spines whereas in *A. phrixocnemoides* these keels are spineless.

Type—♀, Sand Dunes near Headquarters, Petrified Forest, Arizona, July 18, 1940 (E. R. Tinkham; night collecting on sand dunes bordering a large arroyo). Measurements in millimeters: body length 14.0; length to tip of ovipositor 18.0; pronotum 4.5; caudal femora 11.7; ovipositor 5.0; antennae about 20.0 mms. Type in the Tinkham Collection.

Description—Form typical of the Rhaphidophorinae, the subfamily of Camel or Cave Crickets. Hind legs stout, heavy and strong; the large tibial spines mostly grouped together near the apex as is characteristic of the genus. Body gently arched as is typical. Head large, broad and deep, occiput broadly rounded; eyes small, subcircular in outline and placed about centrally on the head. Antennae placed in front of and slightly below the margin of the eyes. Maxillary palpus large and composed of five segments, third and fourth segments longest. Leg spination as follows: fore legs with femora without spination on the lower keels; fore tibiae missing but probably with one large dorsal spine and five pairs of ventral spines as in the genotype. Middle legs with the femora bearing three minute apical teeth on the external inferior keel with the internal keel unarmed; mesotibiae with five pairs of stout dorsal teeth (two pairs slightly basad of center and three pairs apical) and three pairs of small ventral teeth placed beyond the middle and a long pair of apical teeth. Caudal femora with 13 to 15 small widely spaced spines on the externo-inferior keel (Pl. 1, fig. 1) and 12 small black spines on the interno-inferior keel. Caudal tibiae with the external dorsal keel bearing 10 to 11 short and stout spines and 9 very long stout teeth, six of which are apical and the other three separated by a 2-2-3 ratio of the small spines. Inner dorsal keel of the caudal tibiae with 7 to 9 small dark spines and 9 very long stout teeth, 6 of which are apical, the other 3 widely separated with several small teeth in the spaces between them. Ventral surface (dorsal in closed leg) with one pair of small apical teeth and a very small external subapical tooth. Fore and middle tarsi 4-segmented with apical ungues. Caudal tarsi with the three proximal segments terminated ventro-apically in a spine-like projection of each segment and the ventral keel of the fourth segment bearing a row of very minute teeth. Subgenital plate broadly triangular.

Coloration—General coloration pale tan with the posterior margins of the thoracic and abdominal segments dark reddish brown. Outer pagina of the caudal femora with a network of circular and obliquely parallel lines indicating the underlying masculature. The spines on the inferior keels of the caudal femora are piceous and the apices of the long tibial teeth are tipped with black.

Comparison of the leg spination with that of specimens of *Ammobaenetes phrixocnemoides*, from the White Sands of New Mexico, as follows: Fore legs with the femora unarmed below; foretibiae with four large apical and subapical teeth on the ventral keels and one long dorsal apical tooth. Middle

legs with the femora possessing a pair of small apical spines on the ventral keels; mesotibiae with 5 pairs of dorsal teeth and 3 pairs of ventral spines (the subapical small and one of the apical pairs larger). Caudal femora *without* teeth on the lower or inferior keels (heavily toothed in *A. arizonensis* n. sp.). Caudal tibiae with 7 instead of 6 large dorso-external teeth grouped together in the apical half with two much smaller teeth in the basal half, each separated by a number of small fine teeth (progressing from the center proximally) and not 2-2-3-3 as in *A. arizonensis* n. sp. (Pl. 1, figs. 1, 2). Dorso-internal keel with 7 very long and slender teeth grouped in the apical half with two much smaller teeth interspersed with 4 to 7 minute teeth in the basal half. Caudal tarsus apparently 4-segmented with terminal slender ungues; first and second segments of equal length, the second produced into a long ventrad projecting spur; third segment much shorter than the first and second and terminating in a ventral tooth: fourth segment long and slender. The caudal tarsus is quite distinct from that observed in the new species (Pl. 1, figs. 1, 2).

Habitat—The photograph (Pl. 2, fig. 1) shows the type locality of the habitat of *A. arizonensis* Tinkham, near Headquarters in the Petrified Forest of Arizona. The picture shows a small area of sand dunes bordering a large wash or arroyo where the principal plants are: *Sporobolus Wrightii* (tall grass in the center foreground), *Ephedra viridis* (dark plants in left background), some *Atriplex canescens* and other perhaps rarer plants not discernible in the photo. Here specimens of *A. arizonensis* were rare as only one pair was taken in several hours of night collecting. Unfortunately the female destroyed part of the male's genitalia (they were kept alive several days for observation) and rendered the structure imperfect for description.

Habits—The literature contains very little concerning these animals. My specimens were very wary and with their extraordinary saltatorial powers were such that it was exceedingly difficult to capture them at night with the aid of only a flashlight. Usually they disappeared into the night with a single leap of about six feet. One such jump landed the male specimen on top of a small piece of old cardboard six feet away. Hearing this sound was its downfall for it was then carefully stalked and captured. Both sexes dig rapidly into soft sand and their actions resemble those of a dog digging into the hole of a gopher or other rodent. When thus digging actively with their forelegs, they kick the sand backwards with the basket-like clump of long teeth implementing their hind tibiae. The tiny male, about three quarters of an inch long can throw sand backwards forcibly for a distance of 12 to 16 inches which would be the equivalent of a medium sized dog kicking dirt and rocks backwards to a distance of thirty or forty feet. The following observations made on *A. phrixocnemoides* at night on the White Sands of New Mexico probably apply as well to the new species. When the sands are drifting over the dunes the adults are found on the leeward side of the dunes where the drifting sand is settling down. Here they work through the shifting sands like burrowing sand crabs along the sea shore. Their front legs are actively working in a digging motion and their mouthparts

and long palpi, buried in the drifting sand, work it over for bits of organic matter, like Gomphine naiads working over a sand bar in a stream. When thus feeding they are not difficult to capture. When ovipositing the female lies motionless in the drifting sand, which soon covers her, and makes no effort to move until egg laying is completed. When the sand is damp both sexes can rapidly excavate burrows, but with loose dry sand much digging avails them little. In confinement these creatures are fascinating to watch but one must take care that the sand they kick so violently doesn't rebound from the sides of the container and land in one's eyes.

Orthopteran Associates—Orthopteran members of the environment inhabited by *A. arizonensis* Tinkham, include the beautiful decticid *Plagiostira albonotata* Scudder, taken by night collecting in *Chrysothamnus* and other plants) and *Eremopedes balli pallidus* Tinkham (1944). *Eremopedes scudderi* may also occur as it was found for the first time in Arizona, at Concho, not far east of here. *Xanthippus montanus* is also an arenicolous species of this area as are also *Mestobregma impexum* and *Trimerotropis bilobata. Derotmema haydenii haydenii* and *Mestobregma terricolor* may also be found.

Faunistics—A. arizonensis Tinkham, is a member of the Great Basin Desert Fauna that finds the extreme southeastern limits of its distribution in this region (see map, Tinkham 1944). The range of this new species may eventually be shown to be quite extensive throughout the sand dune areas of northern Arizona.

New North American Records

ACRIDIDAE

OEDOMERUS CORALLIPES Bruner, 1908

Pl. 2, Figs. 3, 4; Pl. 3, Fig. 3

1908. *Oedomerus corallipes* Bruner. Biol. Cent. Amer. Orth. **2**:293, pl. IV., figs. 10, 10a, 14, 14a (♀ San Jose del Cabo, Lower Calif.).

1908. *Oedomerus nigropleurus* Bruuner. Ibid. p. 294 (♂, Cape St. Lucas, Lower California).

1923. *Oedomerus corallipes* Hebard. Proc. Calif. Acad. Sci., 4th Series **12**(15):319-340, figs. 1-3.

On the evening of April 24, 1942, the writer stopped to collect Orthoptera in the barren Gila Mountains, some 22 miles east of Yuma, Arizona. Plant life here is scarce and consists chiefly of stunted xerophytes. Animal life also is rare, but nevertheless very interesting.

Flora—The chief plant shrubs at 800 to 1200 feet altitude, are scattered plants of the Elephant Trunk tree *Busera microphylla,* Bursage *Franseria dumosa,* Creosote bush *Larrea divaricata,* Resin plant *Encelia farinosa* and occasional specimens of *Agave deserti* (Pl. 3, fig. 3). Other smaller plants include *Fagonia chilensis* (belonging to the Zygophyllaceae as does *Larrea*), the tall slender and leafless *Hoffmanseggia microphylla,* Beavertail Cactus

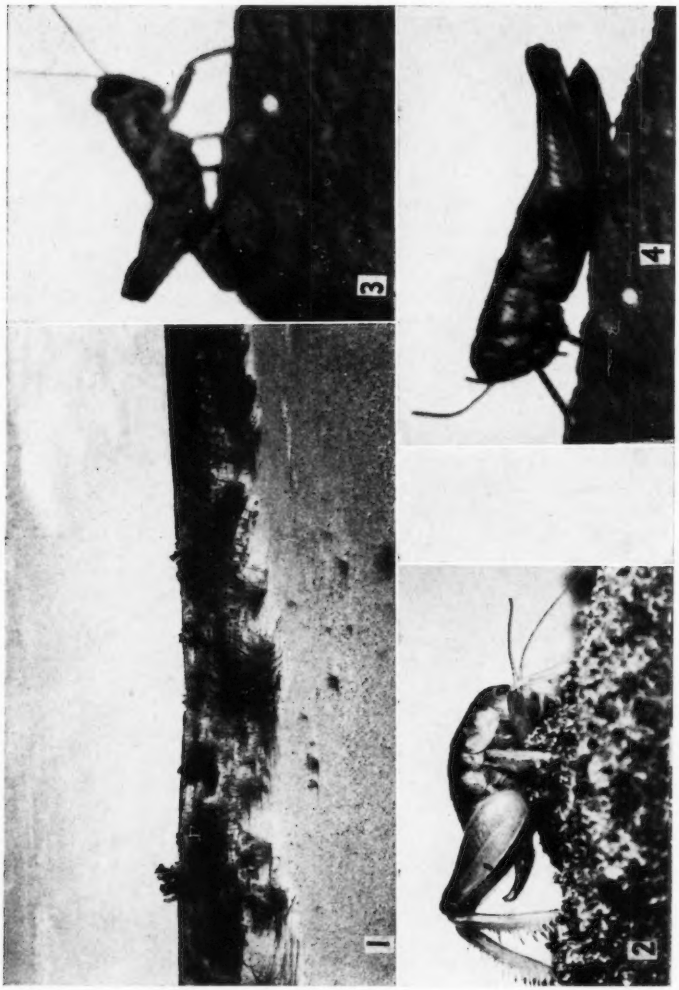

PLATE 2.—Figs. 1-4: 1. Type locality of *Ammobaenetesarizonensis* n. sp. (Petrified Forest, Arizona); 2. *Ammobaenetes arizonensis* n. sp. Type female; 3. *Oedomerus corallipes* Male; 4. *Oedomerus corallipes* (femalle).

Opuntia basilaris, Hibiscus denudatus and *Horsfordia Newberryi* growing sparingly out from under boulders of talus slopes. At higher elevations of from 1000 to 1300 feet occasional Ocotillos *Fouquieria splendens* and Silver Cholla *Opuntia Bigelovii* are found. *Franseria ilicifolia* with its spiny sclerophyllous leaves is rare. A few Palo Verde *Cercidium microphyllum* and Ironwood *Olneya tesota* sprinkle the arroyo courses and only rarely a Giant Cactus or Sahuaro *Carnegiea gigantea* is to be seen on the mountain slopes. This in brief describes the flora of this barren granite range.

Orthopteran species were very scarce in this area and the distance between individuals was considerable. *Tytthotyle maculata,* the Malpais Lubber, though rare was the species most commonly taken; one male and one female (teneral adults) and several nymphs were found. A few specimens of *Arphia aberrans* and one male of *Lactista oslari* were also captured.

Shortly before sundown I discovered a grasshopper new to my experience. A female of this unusual acridid was taken in a clump of *Fagonia chilensis* and *Franseria dumosa* on the rocky mountain slope. About twenty feet away a male was discovered (Pl. 2, figs. 3, 4). The saltatorial powers of this form were considerable and the habits unique among Nearctic Acrididae. As soon as it alighted on a stone or boulder it would immediately crawl in under the rocks. It led its would-be captor a merry chase and many rocks were removed in several different places before the elusive creature was captured because it always jumped as soon as it was exposed. The mountainous slopes were searched in vain the next day from 8 a. m. until 2 p. m. but no additional specimens were taken. In fact more specimens of Acrididae were taken in the hour before sundown on April 24, than in six hours of search on the next day. One wonders if the grasshoppers in this area do not hide under rocks during the intense heat of the day.

The study of this pair of Acridids revealed that they were none other than the exceedingly rare and little known *Oedomerus corallipes* Bruner, which was described and until now known only from three males and six females collected at Las Pas, Lower California; Guaymas, Sonora; Espiritu Santo, Santa Cruz and Mejia Islands in the Gulf of California. Consequently these are the first North American records north of Mexico and their discovery in the Gila mountains extend their distribution northward some four hundreds of miles.

Description—This strange genus is characterized by the following features: head with large conspicuous eyes very narrowly separated at the vertex; pronotum broad with the lateral margins rounding broadly and evenly into the lateral lobes. The chief diagnostic feature however, is in the pronotum where the metazona is observed to be very short and not more than one third the length of the elongated prozona. The pronotum widens perceptibly caudad, especially in the female and the posterior margin is gently concave. The prosternal spine is very low and broad at the base and the tegmina and wings are represented by mere scale-like elliptical pads. The tibiae possess only 6 external and 7 internal spines, no other Nearctic acridid

baeneles arizonensis n. sp. Type female; 3. *Oedomerus corallipes* Male; 4. *Oedomerus corallipes* (femalle).

PLATE 3.—Figs. 1-3: 1. Typical habitat of *Aidemona azteca* at lower edge of the Sonoran Live Oak Zone in the Santa Rita Mts.; 2. Typical habitat of *Tanaocerus koebelei* in the Black Mts. of Northwestern Arizona; 3. Typical habitat of *Oedomerus corallipes* in the Gila Mts east of Yuma, Arizona.

having so few. The coloration is tawny, flecked profusely with fine grey spots, and the caudal tibiae are pale glaucous gray. The female measures in millimeters: length 23.0; pronotum 5.6; prozona 4.1; metazona 1.5; tegmina 3.0 x 0.75; caudal femora 11.5 x 3.0 and the antennae 7.5 mms.

Biology—The life history is probably similar to that of other orthopterans of the xerothermic portions of the Sonoran desert since the ova hatch in the late summer or fall with the advent of the sparse rains. By December or January the nymphs become mature adults which persist until the heat of May destroys them.

Habits—These unusual acridids appear to be strongly troglophilous, readily crawling under rocks to escape detection. The species may also be crepuscular in habits, a tropism more or less induced by the intense heat of the rocks during the day.

Host Plants—These are believed to be *Fagonia chilensis* and *Franseria dumosa*.

Associated Fauna—Oedomerus corallipes was found associated with the following species: *Tytthotyle maculata* (few), *Schistocerca vaga* (few), *Arphia aberrans* (few), *Lactista oslari* (rare) *Trimerotropis p. pallidipennis* (few) and *Tanaocerus koebeli* (extremely rare).

Faunal Designation—Oedomerus is an inhabitant of the more xerothermic portions of the Lower Sonoran Faunal Zone which extend from Mexico up the Gulf of California and reach their northernmost limits in this latitude. At present these are poorly understood but their presence indicates affinity between the fauna and flora of extreme southwestern Arizona and the southern half of Lower California. This fauna can be called the California Gulf Fauna and is one of several faunae composing the life of the Sonoran Desert. Actually this fauna may represent elements of the distinct desert of Lower California which penetrate northward to merge with various elements of the Sonoran Desert.

AIDEMONA AZTECA (Saussure)

Pl. 3, Fig. 1

Finding a strange-looking nymph in Madera Canyon of the Santa Rita Mountains in October, 1938, led to the discovery of this interesting grasshopper in Arizona. Not only is this the first record of this Mexican genus for Arizona but it is also the first North American record north of Mexico. Returning to Madera Canyon in late October and early November of that year the writer found the first adults.

Coloration—The adults are very similar in size and coloration, the males measuring ¾ and the females ⅞ inches in length to the apices of the tegmina which very briefly extend beyond the tip of the abdomen. The coloration is medium to dark brown, profusely flecked with minute spots of blackish. The sternites are yellowish. The posternal spine is diacritical in that it is a thin transverse wedge; no other genus in North America possesses this distinctive feature.

Biology—The adults mature in late October and early November and live through until the following July and early August. Dissection of many females has shown that there is no development of the ovaries until the following June. The dark brown ova are laid in July and the nymphs emerge in late August or early September with the advent of the summer rains. The nymphs feed on the soft flowers of *Eriogonum Wrightii.*

Habitat—The habitat of *Aidemona* is in the dried oak leaves and clumps of grasses and other plants such as *Calliandra* which are found growing under Mexican Blue Oaks (*Quercus oblongifolia*) in the Santa Rita Mountains, Canillo Hills and other mountain ranges in south central Arizona. These oaks characterize the lower limits of the Sonoran Live Oak Zone in the mountains of south central Arizona and represent the Upper Sonoran Faunal Zone.

Associated Fauna—Aidemona azteca is found usually associated with the following interesting acridids: *Rhammatocerus* (*Scyllina*) *viatoria viatoria, Amblytropidea mysteca, Tomonotus ferrugineus, Achurum sumichrasti* and *Prorocorypha snowi.* In the Tumacacoris it was also found associated with *Perixerus gloriosa.* It is interesting to note that members of this entire group belong to a fauna whose northernmost limits of distribution are found in this region. It extends south as far as the limits of oaks in southern Mexico and northern Guatemala, or possibly even further south. Similarly they form a group of acridids that hatch from eggs in the fall, develop throughout the winter months as nymphs and in the warm months of May and early June become adults. The ova are laid usually in July.

Collections—The following specimens were taken in Arizona: Madera Canyon, Santa Rita Mts., 4 nymphs, Oct. 11, 1938; 2♂, 3♂, Nov. 3, 1938; 8♂, 4♀, July 4, 1940; 6♂, 3♀, 2 nymphs, Nov. 10, 1940; 3♂, 2♀, July 28, 1941. Florida Canyon, Santa Rita Mts., a number of specimens taken throughout June and July to Aug. 4, 1941 and on June 28, 1942. Canillo Hills, 5 miles south of Sonoita, Arizona, 1♂, 1♀, Nov. 8, 1940. Tumacacori Mts., 25 miles west of Nogales, Arizona, 3♂, 2♀, Nov. 9, 1940 (under oaks on grassy mountain side). Baboquivari Canyon, west side of Baboquivari Mts., Arizona, 3♂, 2♀, June 22, 1942 (rare). The following specimens were taken in Mexico: Sonora, Mexico, about ten miles south of Nogales, 1♀, Nov. 5, 1939 (rare). Neuvo Leon, Mexico, Galiana Canyon about 10 miles below Iturbide, 1♀ (worn) and several nymphs, Aug. 29, 1940 (E. R. Tinkham).

Attempts to find this species in Box Canyon which separates the Santa Ritas from the Empire Hills to the north, were futile. At present Florida Canyon located in the northwestern portion of the Santa Ritas, just north of Madera Canyon and southwest of Box Canyon represents the northernmost limits of the distribution of *Aidemona.* In Arizona *Aidemona* is now known from the Canillo Hills west through the Tumacacoris to the west side of the Baboquivaris and north to Florida Canyon. It should also be found in the Huachuca Mountains. This species was previously known as far north as Villa Union and Venvidio, Sinaloa. The above records are the first for the state of Sonora, Mexico.

Range—Aidemona azteca ranges south from Arizona to Columbia, South America, and in northeastern Mexico it extends as far north as Galiana Canyon in southern Neuvo Leon.

New Arizona Records

ACRIDIDAE

TRIMEROTROPIS LATICINCTA Saussure

Pl. 4, Fig. 7

Although not previously reported from Arizona, this species has been confused with *T. latifasciata* Scudder, which was reported by Ball and others from southeastern as well as northern Arizona. The representatives from southeastern Arizona actually were specimens of *T. laticincta.*

T. laticincta is found commonly associated with *T. melanoptera* McNeill, and rarely with *T. magnifica* Rehn, in the tall grass areas of southeastern Arizona. Their favorite habitat is bare areas which have been denuded of grass by the colonies of the ant *Pogonomyrmex.* Ridges running near the roads are also favorite places.

Adults of *T. laticincta* closely resemble *T. melanoptera* in coloration but the abdominal sternites are salmon red and not salmon pink as in *melanoptera;* in the latter species the thoracic sternites are largely suffused with salmon pink as well. However, the wing band in *melanoptera* is ¾ of an inch in breadth, lacks a taenia and the yellow wing disc is narrowed to ¼ of an inch. In *laticincta,* Arizona specimens have the band almost ½ of an inch in breadth with a short blunt taenia not more than ⅛ of an inch in length and the yellow wing disc is ⅜ of an inch in breadth. Both specimens are very similar in the possession of hyaline areas at the apices of the wings, clear for about ¼ of an inch.

However, the differentiation between *T. laticincta* and *T. latifasciata* is very difficult and troublesome. Comparing *laticincta* with *latifasciata* (Pl. 4, figs. 5, 7, 10) we find that the latter has a wing band only ¼ of an inch in breadth with only slight variation either side; a taenia almost one quarter of an inch in length and somewhat acutely tipped and a yellow disc one-half of an inch in breadth. The hyaline portions of the wing tips are almost one-half inch in breadth. It is also observed that the weaker veins on the edge of the outer periphery of the black band are mainly colored white whereas in *laticincta* and in *melanoptera* practically all the finer veins edging the outer periphery are black.

In addition the second cross bar of the tegmina in *latifasciata* is incomplete and does not reach from the fore to the hind margin and is formed of a small conglomeration of isolated and fused dark annuli. In both *laticincta* and *melanoptera* (Pl. 4, figs. 6, 7) the second band reaches from the fore to the hind margin and is more or less completely fused and solid although the edges are not straight but rather ragged.

It is felt that these descriptions amply differentiate the three species especially when supplemented with observation of the figures supplied.

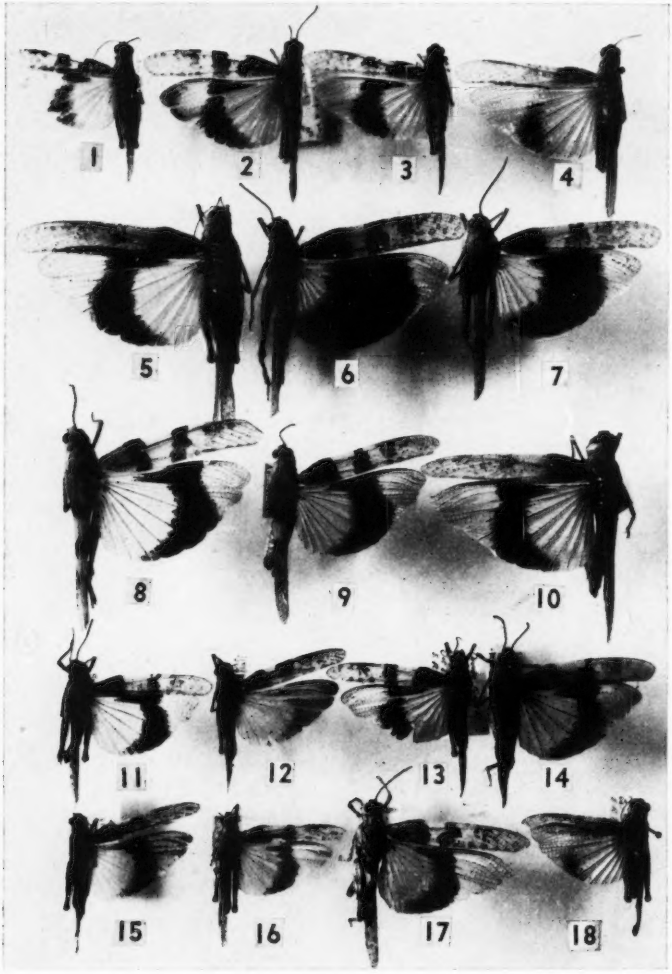

PLATE 4.—Figs. 1-18: *Trimerotropis arizonensis* n. sp. Type Male. Black Mts of extreme Northwestern Arizona, (wings green); 2. *Trimerotropis cyaneipennis*. Male Santa Rita Mts. Southern Arizona (wings glaucous); 3. *Trimerotropis cyaneipennis* Male. Maria Canyon, Utah, (wings bluish); 4. *Trimerotropis sparsa* Male. Grand Canyon (wings pale azure); 5. *Trimerotropis latifasciata* Female. Springerville, Arizona; 6. *Trimerotropis melanoptera* Male. Baboquivari Mts., Ariizona; 7. *Trimerotropis laticincta* Male. Baboquivari Mts., Arizona; 8. *Trimerotropis pistrinaria* Male. Sabino Canyon, Santa Catalina Mts.; 9. *Trimerotropis strenua* Male. Chiricahua Mts.,

T. laticincta and *T. melanoptera* with *T. magnifica* are associated members of what the writer calls the Southwestern Grasslands Fauna of the Upper Sonoran Zone which extends from southeastern Arizona to the Grasslands of the Big Bend Region of Trans-Pecos Texas and thence north to southeastern Colorado and southwestern Kansas. *T. latifasciata* belongs to the Great Basin Fauna and is found in the grasslands of northern Arizona.

TRIMEROTROPIS TITUSI Caudell, 1905

1905. *Trimerotropis titusi* Caudell. Proc. ent. Soc. Wash. **7**:225.

Specimens of a small species of *Trimerotropis* living on or near the granite rocks of the Dells, near Prescott, and on granitic soils in the Pine zone of the Hualpai Mountains of Arizona, very closely resemble *T. strenua* McNeill, with which it is often associated but from which it differs in a number of respects. The general coloration is similar but the size is smaller than in *strenua* and the caudal tibiae are pale yellowish instead of the coral red as always found in *strenua*, in this respect closely resembling the caudal tibiae in *T. p. pallidipennis* (Burmeister). *T. titusi* also lacks the tooth on the posterior inferior margin of the lateral lobe of the pronotum which is usually present and characteristic of *T. strenua*. Of the Arizona species of the genus *Trimerotropis*. now raised to eighteen by those described and discussed in this paper, only three additional possess yellowish caudal tibiae, namely; *pallidipennis, cristata* and *bilobata*. The two latter are distinguished by the elevated bilobate prozona of the pronotum. From *T. pacifica* Bruner, *T. titusi* is separated by its smaller size, the narrower bands on the tegmina and wings and the clearer grayish white body coloration. The present specimens appear to fit the description of *T. titusi* described from Spreckels, Monterrey County, California, better than that of any other species although the black wing band in the Arizona specimens is slightly more prominent.

Collections—The Dells, 7 miles north of Prescott, Arizona, 4♂, Oct. 18, 1939 (E. R. Tinkham; on or near granite boulders). Hualpai Mountains, Arizona, 14 miles southeast of Kingman, 2♂, Oct. 19, 1939 (E. R. Tinkham; granitic soil near pines and chaparral).

Description—The general coloration of the Arizona specimens is pinkish white or light stone gray with two very narrow solid bands with slightly irregular margins, in the basal half of the tegmina. The disc of the wing is lemon yellow, outwardly bordered by a narrow curved band of black considerably narrower than that in *strenua* and more similar to that observed in *cristata*. The inward projecting taenia, observed in most species of *Trim-*

Arizona; 10. *Trimerotropis latifasciata* Female. Shiprock, New Mexico; 11. *Trimerotropis campestris* Male. San Francisco Peaks, Arizona; 12. *Trimerotropis cincta* Male. Lupton, Arizona; 13. *Trimerotropis inconspicua* Male. 15 miles N.E. Flagstaff, Arizona; 14. *Trimerotropis tolteca modesta* Male. Patagonia, Arizona; 15. *Trimerotropis bilobata* Male. Lupton, Arizona; 16. *Trimerotropis cristata* Male. Yuma, Arizona; 17. *Trimerotropis p. pallidipennis* Male. Santa Catalina Mts., Arizona; 18. *Trimerotropis sparsa* Male. Panamint Mts., California.

erotropis, is lacking in this species. The posterior angle of the lateral lobes of the pronotum lacks the small tooth characteristic of *strenua.* The caudal tibiae are pale yellowish white with short black tipped spines and the markings of the caudal femora closely resemble those observed in *strenua.*

Habitat—This pecies appears to be very local in distribution and seems to be restricted to granitic rocks such as those encountered in the Dells, just north of Prescott, and in similar areas in the granitic Hualpai Mountains well over one hundred miles to the west.

Orthopteran Associates—T. titusi is found associated with *T. strenua, T. p. pallidipennis, Conozoa carinata, Trachyrhachis kiowa kiowa, Leprus glaucipennis, Aulocare elliotti, Ageneotettix d. deorum, M. gladstoni* and other species.

Faunistics—T. titusi appears to be a representative of the fauna of the Upper Sonoran Zone and is a species characteristic of the Chaparral of northwestern Arizona. Certain elements of the Chaparral fauna are especially Californian in origin. These are: *Morsea california dumicola,* a Eumastacid, the newly described *Timema ritensis* Hebard, 1937, and *Gamarotettix apache* Rehn, 1940. These and *titusi* are members of an earlier, more extensive and cohesive Californian fauna, of which only relics appear to survive in Arizona.

As one new species of *Trimerotropis* has been described, and two additional species have been added to the Arizona list, it is felt that a key would be of value to the student at this time.

KEY TO THE ARIZONA SPECIES OF THE GENUS TRIMEROTROPIS

1. Wing disc yellow 4
   Wing disc not yellow 2

2. Wing disc azure blue without solid black band; caudal tibiae yellow ..... *sparsa* (Thos.)
   Wing disc green, bluish or greenish blue 3

3. Wing disc greenish blue to bluish; band fairly broad with apex infumate. Pronotum at least 4.5 mm. long. Caudal tibiae bluish ..... *cyaneipennis* Br.
   Wing disc greenish; band of wing narrow and poorly defined. Pronotum only 3.5 mm. long. Caudal tibiae greenish ..... *arizonensis* Tink.

4. Black band on wing very broad, broader than the yellow disc 5
   Black band on wing narrower, usually much narrower than yellow disc 6

5. Band exceedingly broad, occupying 2/3 of total wing length. Disc 1/3 the width of the band. Abdominal and thoracic sternites salmon pink ..... *melanoptera* McN.
   Band very broad, occupying 1/2 the total wing length. Disc 2/3 the breadth of the band. Abdominal sternites only, salmon red; the thoracic sternites whitish, faintly tinged with reddish ..... *laticincta* Sauss.

6. Caudal tibiae yellowish 7
   Caudal tibiae not yellowish 10

7. Prozonal carina cristate and distinctly bilobate. Tegmina without distinct fasciations or bands 8

Prozonal carina not cristate, the lobes indistinct and more or less fused. Tegmina with distinct crossbands 9

8. Posterior angle of the lateral lobes of the pronotum with a small tooth. Sonoran desert ..... *cristata* McN.
Posterior angle of the lateral nobes without teeth. Color darker gray. Wing band more uniformly broad. Great Basin Desert ..... *bilobata* R. & H.

9. Size large; coloration grayish with wide and irregular crossbands in the basal half of the tegmina ..... *pallidipennis*
Size small; coloration pinkish white with two uniformly narrow crossbands in basal half of the tegmina ..... *titusi* Caud.

10. Caudal tibiae orange or red 12
Caudal tibiae not orange or red 11

11. Caudal tibiae pale bluish. Apex of wings infumate ..... *cincta* Thos.
Caudal tibiae grayish. Outer half of wings black ..... *suffusus* Sc.

12. Size very large. Antennae very long and heavy ..... *magnificus* Rehn
Size smaller. Antennae shorter, slender, never heavy 13

13. Posterior angle of the lateral lobes of the pronotum with a tooth ..... *strenua* McN.
Posterior angle of the lobes without a tooth 14

14. Veins bordering outer edge of wing band mostly white. Tegmina without crossbands, the fasciations composed of small clusters of fused annuli .... *latifasciata* Sc.
Veins bordering the outer edge of wing band mostly black. Tegmina banded; the basal band complete and uniform in breadth 15

15. Tegmina usually pinkish, with two uniformly broad bands, widely spaced, crossing tegmina. Wing band 1/4 inch in breadth. Size large ..... *pistrinaria* Sauss.
Tegmina not as above, the second or median band usually much narrower on the front margin. Size usually small 16

16. Tegmina and metazona of the pronotum with scattered black dots .. *campestris* McN.
Tegmina and metazona not profusely spotted 17

17. Median band narrowest on the front margin of the tegmina 18
Median band of uniform breadth. Size small ..... *inconspicua* B..

18. Coloration rust red or brownish yellow. Outer half of tegmen rather uniformly colored. Wing band 3/16 inch in breadth ..... *tolteca modesta* Br.
Coloration stone gray or pinkish white. Outer half of tegmen with an incomplete outer or dark band. Wing band 1/4 inch in breadth ..... *strenua* McN.

TANAOCERUS KOEBELEI Bruner

Pl. 4, Fig. 2

One of the rarest and most interesting of desert acridids is the tiny *Tanaocerus koebelei* which until recently was known only from the type locality, the Panamint Mountains, where Koebele discovered it in April 1891.

In working over some undetermined material at the University of Arizona, in the fall of 1938, the writer came across a minute nymph taken by Dr. E. D. Ball near Willow Beach, Arizona, some years previously. The writer decided to find out more about this curious creature when the first opportunity presented itself. In October, 1939, he made a long collecting trip across the desert to the Sierra Nevadas of California and while en route went into the barren Black Mountains of extreme northwestern Arizona. Here he discovered additional nymphs, feeding at night on *Hymenoclea salsola*. Incidentally the following day while continuing the search he discovered the new species *Trimerotropis arizonensis* Tinkham.

From here the author's trail led across Boulder Dam, Lake Mead to Beatty, Nevada, and west across the Funeral Mountains, Death Valley, the Panamints and other ranges to the Sierra Nevadas. *Tanaocerus* was found at practically every desert stop where *Franseria dumosa* constituted one of the codominant plants.

Although rare, nymphs of *Tanaocerus* can be found in the fall by diligent searching. However by spring when the species has become mature, specimens are exceedingly rare, probably the price paid for the precariousness of desert existence. In the fall, collections revealed a preponderance of female to male nymphs. By spring, only a few females survive; males are apparently wanting since long and diligent searching failed to discover any. The only known adult male was taken by the author in the Gila Mountains in December 1940. This specimen was kept alive and observed for five weeks after which it made a spectacular escape. Unfortunately the writer did not know the rarity of his find at that time.

Collections—Arizona: Black Mountains of northwestern Arizona, about twenty miles south of Boulder Dam and several miles east of the Colorado River, Oct. 18-19, 1939, 1♂ nymph, 13♀ nymphs (E. R. Tinkham; on *Hymenoclea salsola* by night collecting and *Franseria dumosa* in day collecting). Gila Mts., 25 miles east of Yuma, elevation about 1100 ft., Dec. 27, 1940, 1♂ (E. R. Tinkham; later escaped on Feb. 14, 1941; on *Franseria dumosa* on steep rocky slope); 2♀, Dec. 31, 1941; same habitat; 2♀, Feb. 2, 1941, same habitat.

Nevada: Lake Mead, 1 mile north of Boulder Dam, Oct. 19, 1939, 1♂ nymph (E. R. Tinkham; on *F. dumosa*). 20 miles south of Las Vegas, Oct. 19, 1929, 2♀ nymphs (E. R. Tinkham; on *F. dumosa*). Desert mesa near east base of Mt. Charleston and about 22 miles NW. of Las Vegas, Oct. 19-20, 1939, 2♂ nymphs, 4♀ nymphs (E. R. Tinkham; on *F. dumosa*, day and night collecting); 5♀ adults, March 31, 1942 in this same general vicinity. Seven miles south of Indian Springs, Oct. 20, 1939, 1♀ nymph (E. R. Tinkham on *F. dumosa*). Six miles south of Beatty, Oct. 20, 1939, 6♂ nymphs, 11♀ nymphs (E. R. Tinkham; on *F. dumosa*, night collecting).

Description—The general coloration of the female is grayish with antennae about eaqual to the length of the body. The female is humped-backed and totally unlike other Nearctic acridids in that the body is very soft.

Biology—As the nymphs are present in October, the eggs undoubtedly hatch during the late summer rains in late August or early September. The nymphs mature in late December or January and live until April. The desert heat probably kills them off before mid-May as repeated attempts over broad expanses of the desert at this time failed to reveal any specimens.

Habits—The tiny male is a remarkable jumper but unlike other acridids which leap horizontally, it springs vertically into the air in high curving loops. The nature of these leaps apparently enable the male to eventually land on the top of a clump of its host plant *Franseria dumosa* which is found scattered every few feet in its desert environment. The male is almost impossible to

follow or catch. The female is soft bodied and sluggish with its saltatorial ability reduced—being able to jump only one to two feet. The nymphs are found at night perched on the top twigs of its host plant and occasionally on other desert plants. During the day the nymphs often wander a few feet away from the host plant on foraging trips.

Habitat—T. koebelei is a species peculiar to the Nevada Desert subtype. Its favorite habitat appears to be stony or gravelly soil on the desert mesas where *F. dumosa* is usually codominant with *Larrea* the Creosote bush (Pl. 4, fig. 2). In southern Arizona it has been taken only at higher elevations in the Gila Mountains although it has been diligently searched for on *dumosa*-covered mesas.

Host Plants—Franseria dumosa is the preferred host plant over the entire range of the species. In the Black mountains the writer found it feeding on *Hymenoclea salsola* in the arroyos by night and on *D. dumosa* and *Coleogyne ramosissima* on the hillsides by day. Dr. Ball's specimen was taken on *Coleogyne*. Throughout Nevada and California *F. dumosa* appears to be the host plant.

Orthopteran Associates—These are few because the adults mature in winter when orthopterans are few. Nymphs of *Arphia aberrans, Tytthotyle maculata, Lactista oslari* and adults of *Schistocerca vaga* and *Trimerotropis p. pallidipennis* are its chief associates.

Distribution—In Arizona *T. koebelei* has been found only in the Gila and Black Mountains. Attempts to locate it in the Mohawk mountains, fifty miles east of the Gilas, failed and it could not be found in likely spots in the mountains east of Blythe and at Granite Pass. In Nevada it was found from Lake Mead to Beatty and from thence west to the Funeral Mountains, the Panamints and the Cosa Range bordering Owen's Valley on the east. From the latter range it is distributed south to the Mojave Desert.

CONALCAEA HUMPHREYSII POECILA Hebard, 1925

1925. *Conalcaea poecila* Hebard. Trans. Amer. ent. Soc. **51**:290, pl. 7, fig. 7, pl. 8, fig. 4.

When describing this species in 1925, Hebard stated that it was "very closely related to *C. humphreysii* (Thomas) which is known from southern Arizona and Sonora, Mexico."

In early November, 1939, the writer made a collecting trip in Sonora as far as thirty miles south of Hermosillo and during this excursion had an excellent opportunity to study the acridid fauna in northern Sonora. On this trip 4♂, and 3♀ of *Conalcaea poecila* were first discovered about seven miles northeast of Magdalena, Sonora, where the first Sahuaros begin and here the species was abundant. Orthopteran associates here were *Brachystola ponderosa* and *B. magna* (the only place where these two species were found associated), *Taeniopoda eques, Phrynotettix tchivavensis* (very large female), *Schistocerca albolineata* and other species. The significance of this locality lies in the fact that it is on the extreme eastern edge of the Sahuaro-Palo

Verde-Encelia zone which merges with Ocotillo and grasslands of the Upper Sonoran zone. This union or merger of the areas involved is illustrated by two species of *Brachystola; magna* of the Upper Sonoran and *ponderosa* of the Lower Sonoran Zone. Between Magdalena and Santa Anna where excellent stands of Sahuaro-Palo Verde-Encelia occur, the dominant grasshoppers were *B. ponderosa, Conalcaea poecila* and *Schistocerca albolineata. C. poecila* is found abundantly south from Santa Anna through Llano to the south of Hermosillo. Thus it is definitely a member of the Sahuaro-Palo Verde-Encelia zone of the Sonoran Desert and is a Lower Sonoran faunal element.

South of Nogales for some forty miles *Conalcaea humphreysii* is found wherever Live Oaks (*Quercus oblongifolia* and *Q. mexicana*) occur, since this grasshopper is one of the characteristic and dominant species of what the writer calls the Sonoran Live Oak Zone of the Upper Sonoran. Northern Sonoran specimens of *C. humphreysii* are identical with those from adjacent areas in south central Arizona which have the caudal tibiae buffy yellow.

The close relationship of the two species, apparently indicates that *poecila* is nothing more than a larger and more vividly colored response of the species to more xeric conditions of desert environment in which the caudal tibiae are of a purplish-red coloration. *Conalcaea h. humphreysii* of smaller size and with buffy yellow caudal tibiae constitutes the Upper Sonoran race found in the Sonoran Live Oak belt.

The Arizona specimens of *C. humphreysii poecila* were taken by the writer in the Cobabi Mountains of the Papago Indian Reservation in the heart of extensive Sahuaro-Palo Verde stands.

The distribution of *C. h. poecila* extends north from Sonora in a narrow band of Sahuaro-Palo Verde-Encelia vegetation (lying west of the Sonoran Live Oak belt) to the Cobabi Mountains of the Papago Indian reservation near the south-central border of Arizona.

MELANOPLUS MAGDALENAE Hebard

This recently described species was discovered by the author in the Magdalena Mountains of central New Mexico, in 1930. It was described and named some years later by Mr. Morgan Hebard of Philadelphia. It is distinguished by the pinkish red coloration of the caudal tibiae and the almost triangular form of the male cercus which is very broad at the base and tapers rapidly to a broadly rounded apex. It closely resembles *M. truncatus* of the Mogollon Plateau and *M. pinaleno* of the Pinaleno Mountains and other members of the same group.

A series of specimens of this interesting grasshopper was taken for the first time in the Escudillo Mountains, three miles south of Alpine, Arizona, in mid-October, 1939, by the writer.

Habitat—M. magdalena was collected around fallen logs and under large ferns on the mountain side in the Poplar-Fir Zone. This Zone is generally found above the upper limits of the Pine Zone at approximately 9500 to approximately 12,000 feet elevation in Arizona.

Orthopteran Associates—These were very few at this elevation and consisted mainly of *Neopodismopsis abdominalis. M. snowi* and *Eremopedes balli* also probably occur in such habitats.

Distribution—*Melanoplus magdalenae* is a member of the Poplar-Fir Zone and is known only from the Escudillo Mountains of extreme central-eastern Arizona and the Magdalena Mountains of New Mexico.

TETTIGONIIDAE: DECTICINAE

EREMOPEDES BALLI PALLIDUS Tinkham, 1944

1944. *Eremopedes balli pallidus* Tinkham. Amer. Midl. Nat. **31**:257-328.

This new subspecies, described from the Petrified Forest region of northeastern Arizona is the desert race of *E. balli* and is distinguished from *balli*, which inhabits the mountains of the Mogollon Plateau, chiefly by its pale coloration, slightly larger size and the absence of two pale stripes on the outer pagina of the caudal femora. The song is not known but is probably a soft "zee-zee-zee-zee-zee" long continued and typical of the various members of the genus.

Habitat—Typically desert with some sparse tall grass (*Sporobolus Wrightii*) and occasional plants of Mormon Tea (*Ephedra viridis*), rabbit brush (*Chrysothamnus sp.*) and salt brush (*Atroplex canescens*) especially along the margins of the washes or arroyos.

Orthopteran Associates—*Ammobaenetes arizonensis* Tinkham, and *Plagiostira albonotata* were taken in this locality. Other species not taken but which are members of this type of habitat are: *Xanthippus montanus, Mestobrgema impexum, M. terricolor, Trimerotropis bilobata, T. p. pallidipennis, Derotmema h. haydenii* and perhaps *Eremopedes scudderi.*

Faunistics—*E. balli pallidus* is a member of the Great Basin Desert Fauna and is known at present only from the type locality but will undoubtedly be found to have a more extensive distribution in the "Painted Desert" region of northeastern Arizona.

EREMOPEDES EPHIPPIATUS SONORENSIS Tinkham, 1944

1944. *Eremopedes ephippiatus sonorensis* Tinkham. Amer.Midl. Nat. **31**:257-328.

This handsome new subspecies, described from desert north of Hermosillo, in the state of Sonora, Mexico, has also been taken from the Baboquivari Mountains of Arizona.

It is of a dark coloration, almost black dorsally and much larger in size than specimens of the nominal race, *ephippiatus* which are of a reddish brown flecked appearance. The tegmina are dark with the veins lighter colored.

The song is a strong "zic-zic-zic-zic" that can be heard at distances up to one hundred feet.

Habitat—The habitat is typically Lower Sonoran and floristically is com-

posed chiefly of mesquite, acacias, and other desert plants and shrubs which often form rather dense growths.

Orthopteran Associates—These include such species as *Eremopedes bilineatus, Arethaea gracillipes* and *covilleae*, and in Sonora, *Rehnia sinaloa*. Other species of grasshoppers such as *Acantherus piperatus* and *Melanoplus* spp. occur in such environments.

Distribution—*E. e. sonorensis* is a member of the Lower Sonoran Fauna and is known to occur in a narrow band of desert vegetation from the Baboquivari Mountains of south central Arizona south into the state of Sonora, Mexico.

EREMOPEDES SCUDDERI Cockerell

1♂ (small), 4 miles east of Concho, Arizona, July 18, 1940 (in clump of dwarf *Yucca* in Pinyon Zone; E. R. Tinkham).

E. scudderi is one of the commonest decticids of the Chihuahuan Desert. The writer has taken it in southern Coahuila and southwestern Neuvo Leon; in the Davis, Chinati and Chisos Mountains of the Big Bend Region of Trans-Pecos Texas; and on the creosote desert north of the Chisos; and also on the Marfa Plains. It also occurs in the Franklin Mountains near El Paso. All of the specimens taken from these localities were of optimum size and typical of those of the Chihuahuan Desert.

The distribution of *E. scudderi* extends north up the Rio Grande Valley to northern New Mexico and then apparently swings west into the desert areas of northeastern Arizona—the Concho male being the first record for Arizona. The diminutive size of this adult male indicates that it dwells on the periphery of its extensive range where climatic conditions are somewhat adverse to its livelihood.

The coloration is usually bright foliage green or dark gray with a criss-crossed row of light colored markings on the dorsum of the abdomen. These markings are often pinkish white in color and give this species an attractive appearance.

The song of this species is a soft "zee-zee-zee-zee-zee" long continued but audible for only some twenty to thirty feet.

Orthopteran Associates—Rehnia cerberus, Eremopedes covilleae, Dichopetala oreoeca, Arethaea semialata are typical associates on the Chihuahuan Desert. At Concho, the acridid *Mestobregma impexum* was the only other member of the habitat.

Host Plants—On the desert proper Creosote bush is the chief host plant. The tassels of flowering Sotol, *Dasylirion texanum, Clematis Drummondi* and undoubtedly other desert plants form the food of this species.

Distribution—*E. scudderi* is confined to the areal extent of the Chihuahuan Desert, and its range extending to the periphery of that desert.

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P. O. Box 464,
Benson, Arizona.

A Study of Polyergus in the United States, Based on the Workers (Hymenoptera: Formicidae)

Marion R. Smith

The genus *Polyergus,* subfamily Formicinae, includes the obligatory or true slave-making ants commonly referred to as Amazons. Unlike most ants, their workers are entirely dependent on slaves for the construction of nests and for the feeding of themselves and their brood. Their chief occupation appears to be the raiding and pillaging of nests of *Formica,* especially of those forms belonging to the *pallidefulva* and *fusca* groups. That portion of the stolen brood which is not eaten develops into auxiliary slaves in the nests of the *Polyergus.*

The Amazons are easily recognized generically by the falcate mandibles, often shining yellowish to reddish body, thick petiole, and clavate antennal scapes.

Although there are only three recognized species and about a dozen subspecies and varieties of *Polyergus* in the world, the ants of this genus nevertheless have a very wide distribution in the Holarctic region. Emery records them from the Caucasus, Central Asia, China, Mongolia, Japan, and in North America as far south as Mexico. The most common form in the Old World is *rufescens* Latreille. In the United States there are nine forms. They consist of three subspecies and three varieties of *rufescens,* and *lucidus* with its two subspecies. The distribution of these forms is not yet fully known, but it is the author's opinion that *Polyergus* may occur in every state with the possible exceptions of Florida, Alabama, and Mississippi, although it should be noted that no specimens have yet been recorded from Texas. *P. lucidus* is the most common form in the East, extending as far west as Iowa and Kansas; *rufescens breviceps,* on the other hand, is the common western form, but its known range extends as far east as Illinois and Indiana. *P. rufescens bicolor* appears to be common in the northern section of the United States, at least from Michigan to Montana and southward to Illinois and Iowa.

The most dependable characters for separating *lucidus* and its forms from those of *rufescens* are the length of the scape as compared with the interocular distance, the sparsity or density of the pubescence on the gaster, and the degree of enlargement of the apical portion of the scape. So far as the author is aware, the slaves of *lucidus* and its forms are ants of the *Formica pallidefulva* group, whereas the slaves of the various forms of *rufescens* are those of the *F. fusca group* (in the broad sense).

In conducting this study the author has been greatly impressed by the amount of variation within a species. This is especially marked in color and pilosity, and to a less extent in sculpturing. In some instances the color of

preserved individuals appears to have faded with age, but often the color varies to a large degree even in fresh individuals from different localities. The general color of *lucidus*, for example, may vary from yellowish to very dark reddish. The infuscation at the apex of the gaster, moreover, may vary considerably even in individuals from the same colony. Not only do the erect hairs that normally occur on certain areas of the body vary with regard to placement and number, but they may occasionally be absent.

The measurements given in this article are to be interpreted as follows: The length of the head is the median length from the anterior border of the clypeus to the posterior border of the head. The width of the head is the greatest distance between the external borders of the eyes. The length of the scape is the length exclusive of the bulblike base, which is buried and therefore cannot be accurately measured.

In conducting this study, which is based entirely on workers, the author has described one new subspecies, *lucidus longicornis*. He has examined cotypes of *rufescens laeviceps, rufescens bicolor, rufescens breviceps umbratus*, and *lucidus montivagus*. He has also examined specimens of typical *lucidus* and of *rufescens breviceps* which are presumably from the original nest series. No specimens have been seen of either *rufescens breviceps fusciventris* or *rufescens breviceps silvestrii*. The original description of each of these forms is quoted, but only *fusciventris* is included in the key. Specimens have been examined from the collection of the United States National Museum, the Museum of Comparative Zoology, the Peabody Museum of Natural History, the Illinois State Natural History Survey, Cornell University, the University of Nebraska, the University of Minnesota, and in those of W. M. Mann, Robert E. Gregg, and Mary Talbot.

For the sake of brevity collectors' names are given by initials. In alphabetical order the names of the collectors are: C. C. Adams, C. N. Ainslie, W. V. Balduf, O. S. Bare, Joseph Bequaert, F. H. Benjamin, W. S. Blatchley, J. C. Bradley, J. C. Bridwell, Wm. F. Buren, A. C. Burrill, A. Champlain, E. A. Chapin, T. D. A. Cockerell, A. C. Cole, Jr., K. W. Cooper, C. H. Curran, W. T. Davis, Edward Norton, Finley (initials unknown), W. J. Fox, A. B. Gahan, Elizabeth V. Gregg, Robert E. Gregg, H. Heath, H. H. Jewett, J. W. Jones, Jr., C. H. Kennedy, G. F. Knowlton, S. H. Lyman, Arnold Mallis, Wm. M. Mann, Henry McCook, H. Muckermann, W. A. Nason, Paul W. Oman, Theodore Pergande, D. M. Rees, B. Rotger, J. A. Rowe, P. J. Schmitt, R. Schuster, L. E. Shinn, F. Silvestri, M. R. Smith, Thomas E. Snyder, A. H. Sturtevant, Mary Talbot, M. C. Tanquary, E. S. G. Titus, Mary Treat, Titus Ulke, H. T. Vanderford, Morton Vogel, L. G. Wesson, Jr., R. G. Wesson, A. Wetmore, W. M. Wheeler, A. S. Windsor.

The only J. C. Bridwell record is that of *breviceps* from Baldwin, Kans.; the other J. C. B. records are those of J. C. Bradley. The only Mary Treat record is that of *lucidus* at Vineland, N. J., and Cape Cod, Mass.; the other M. T. records pertain to Mary Talbot.

The illustration of *Polyergus lucidus* is by Sara H. DeBord.

KEY TO WORKERS[1]

1. Antennal scape usually longer than interocular distance, and although enlarged distally not suddenly dilated to form a club; gaster shining in all lights because of the extremely sparse pubescence; occipital lobes usually with erect hairs; eyes noticeably convex 2

Antennal scape usually shorter than interocular distance, suddenly dilated distally to form a prominent club; gaster subopaque, at least in some lights, because of the dense pubescence; occipital lobes usually without erect hairs; eye often not noticeably convex 4

2. Gaster distinctly infuscated at apex; occipital lobes usually with erect hairs 3

Gaster very faintly or not at all infuscated at apex; occipital lobes often without erect hairs. Colorado ..... *lucidus montivagus* Wheeler

3. Body, with the possible exception of the gaster, subopaque, with a distinct grayish sheen; antennal scape unusually long, 1.45 to 1.55 times the interocular distance. South Carolina ..... *lucidus longicornis*, new subspecies

Body, with the exception of the meso- and metapleura, polished and shining; antennal scape usually less than 1.4 times the interocular distance. Common form in the Eastern States ..... *lucidus* Mayr

4. Entire body of a sordid, reddish-brown color; large and robust, 5.7-6 mm. in length. California ..... *rufescens breviceps umbratus* Wheeler

Color of body not as above; size variable 5

5. Entire gaster, or all but the basal half of the first segment and the anal region, deeply infuscated or blackish 6

If infuscated, the gaster is never so extensively or deeply so as described above 7

6. Entire gaster infuscated or blackish and much darker than the head and thorax, thus giving the body a bicolored appearance. Known range, northern United States from at least Michigan to Montana and southward to Illinois and Iowa ..... *rufescens bicolor* Wasmann

Basal half of the first gastric segment, and the anal region, not infuscated. Colorado. ..... *rufescens breviceps fusciventris* Wheeler

7. Most of the body, but especially the head, shining in nearly all lights; length 4-5.5 mm. (Last 3 or 4 gastric segments more or less infuscated.) California..... ..... *rufescens laeviceps* Wheeler

Most of body, including the head, subopaque in nearly all lights; length 5-7 mm. A common subspecies with a wide distributional range which includes most, if not all, the Western and Midwestern States ..... *rufescens breviceps* Emery

POLYERGUS LUCIDUS Mayr

Figs. 1, 1a

Polyergus lucidus Mayr, 1870, Zool.-Bot. Gesell. Wein. Verhandl. **20**:952, worker, female, male; 1886, *op. cit.* **36**:424; McCook, 1880, Acad. Nat. Sci. Phila. Proc. **32**: 376-384, pl. 19 (biology); Burrill, 1908, N. Y. Ent. Soc. Jour. **16**:144-151 (slave raids); Wheeler, 1916, Ind. Acad. Sci. Proc. **26**:465; 1917, Amer. Acad. Arts and Sci. **52**:555; 1926, Ants, 2d ed., pp. 482-486, figs. 270, 271; Wesson & Wesson, 1940, Amer. Midl. Nat. **24**:102; Jones, 1943, Amer. Midl. Nat. **29**: 185 (distribution); Buren, 1944, Iowa State Col. Jour. Sci. **18**:310 (key to workers); Gregg, 1944, Ent. Soc. Amer. Ann. **37**:476 (key to workers).

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1 *P. rufescens breviceps silvestrii* Santschi is not included in the key.

Polyergus rufescens lucidus Forel, 1886, Soc. Ent. de Belg. Ann. **30**:200; Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:666.

Worker.—Length 6.5 mm.

Head longer than broad, widest through the center of the eyes, with somewhat concave cheeks, rounded occipital lobes, and approximately straight posterior border. Ocelli small, placed in a triangle with the anterior ocellus almost touching an imaginary line connecting the posterior border of each eye. Eye prominent, rather strongly convex, situated about 1.5 times its greatest diameter from the base of the mandible. Frontal carinae short, subparallel, not lobed, placed at a distance from each other approximately equal to their length. Antennal scape curved, gradually enlarging apically but not forming an abrupt and prominent club as in the forms of *rufescens;* length approximately 1.13 times that of the interocular distance. Clypeus somewhat trapeziform, subcarinate in its posterior half. Mandible falcate, depressed, with minutely serrate inner border. Thorax with a distinct promesonotal suture and a rather strong mesoepinotal impression. A prominent spiracle situated on the side of the mesoepinotal impression and another spiracle on the side of the epinotum. Mesonotum forming a gentle arch, highest at the posterior border of the pronotum and lowest at the mesoepinotal impression. Base and declivity of epinotum not clearly delimited, the two

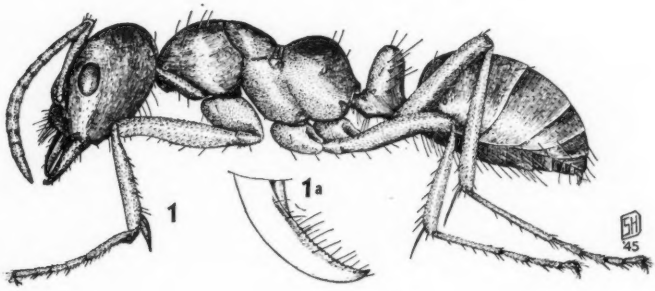

Fig. 1. *Polyergus lucidus* Mayr, worker; fig. 1a, right mandible.

surfaces meeting in such a manner as to form a rounded, obtuse angle. Legs rather long. Petiole thick anteroposteriorly, with anterior surface convex and posterior surface more flattened; sides narrowing dorsally to form a rounded and blunt superior border. Gaster oblong.

Erect hairs present on gula, mandibles, clypeus, occipital lobes, pronotum, petiole, flexor surface of each leg, and the dorsum and venter of the gaster. Pubescence fine, closely appressed, perhaps most easily seen on the appendages, especially in certain lights; very sparse and not concealing the surface of the

gaster, so that the gaster is shining in all lights. Entire body, exclusive of the meso- and metapleura, shining.

Yellowish red, with the appendages and the posterior border of the last four gastric segments infuscated.

Described from a single worker believed to belong to the original nest series from which the cotypes were selected. This worker and a female are borne on a pin to which is attached only the label "152." Three other pins bear the same number. One pin bears three males, another pin four males, and the third pin, a female, a male, and a slave worker. To the third pin is also attached a handwritten label, "*Polyergus* n. sp." The series is from the Peabody Museum of Natural History.

In individuals from different localities this species varies considerably in the length of the antennal scape, pilosity, color, and the amount of infuscation at the apex of the gaster. The length of the scape when compared with the interocular distance varies remarkably, ranging from as low as 1.05 to as much as 1.40 times the interocular distance. Erect hairs are almost always present on the gula, mandibles, clypeus, occipital lobes, pronotum, flexor surface of each leg, petiole, and dorsal and ventral surfaces of the gaster. The mesonotum seldom bears hairs, while the epinotum usually has one or more hairs but sometimes is hairless. Rarely are erect hairs absent on the occipital lobes. The color of the body varies from yellowish through yellowish red to dark reddish, the appendages being moderately to deeply infuscated. The infuscation at the apex of the gaster is also highly variable with regard to depth and extent. Usually the infuscation embraces the posterior border of the last three gastric segments, but it sometimes even includes the posterior border of the fourth segment. Even specimens from the same colony are not always uniformly infuscated.

The so-called shining Amazon is one of our most beautiful North American ants; its red body and infuscated appendages readily catch the eye. The worker can be recognized by the characters given in the key as well as by the fact that the ant apparently never enslaves any *Formica* except those of the *pallidefulva* group. It is the only *Polyergus* known to occur in the extreme Northeastern States, but farther south and west the species breaks up into several subspecies, one of which is described as new in this article. In the Midwestern States the distribution of *lucidus* is overlapped by that of *rufescens breviceps*. The distribution of the species is not yet fully known, but *lucidus* has been found as far south as northern South Carolina and at least as far west as Riley County, Kans.

Type locality.—Connecticut (no specific locality mentioned), Edward Norton. Since Norton lived at Farmington, the types may have been collected there, or in that vicinity.

Other localities.—CONNECTICUT: New Haven, G. E. H. NEW YORK: Ithaca, J. C. B.; Putnam Valley, R. S.; near Bronxville, W. M. W.; Long Pond, Wading River, Pinelawn and Selden on Long Island, W. T. D.; Hulett's Landing in Washington County, T. E. S.; White Plains and West Nyack, J. B. MASSACHUSETTS: Boston, S. H.; Falmouth and West Falmouth, A. H. S.; Cape Cod, M. T.; Blue Hills Reservation, collector? NEW JERSEY: Camden County, collector?; Clementon,

W. J. F.; Vineland, M. T.; Princeton, K. W. C.; New Brunswick, collector?; Martha, 40 miles west of Philadelphia, H. G. PENNSYLVANIA: Rebersburg, L. E. S.; Rockville, A. C. and P. R. M.; Milford, A. C. B.; Bellwood, H. McC. MARYLAND: Berwyn, A. B. G. DISTRICT OF COLUMBIA: locality?, T. P. and W. M. M.; Rock Creek Park, M. V. VIRGINIA: Bristol, J. W. J.; Vienna, E. A. C., M. R. S., and J. C. B.; East Falls Church, E. A. C.; West Falls Church, J. C. B.; Bull Run, W. M. M. NORTH CAROLINA: Belmont, P. J. S.; Conover, H. T. V. (not *lucidus* in the strict sense). SOUTH CAROLINA: Whitewater Falls, M. R. S. TENNESSEE: Bluff City, Ringgold, J. W. J. Jr. KENTUCKY: Lexington, H. H. J. OHIO: 2 miles west of Beaver, L. G. W., Jr., and R. G. W. INDIANA: Pine, W. S. B. MICHIGAN: Asca near Afton, C. H. K.; Cheboygan County and Ogeman Game Refuge in Roscommon County, M. T. ILLINOIS: Rockford, W. M. W. IOWA: Backbone State Park, W. F. B. KANSAS: Riley County, collector? MISSISSIPPI: Abbeville, J. W. J., Jr. (this record is questionable, as a few straggling workers were collected near a railroad track and they may have been brought in by the railroad). COLORADO: Garden of the Gods, H. McC. (this may be *lucidus* in the broad sense).

Cotypes presumably in Naturhistorisches Museum, Vienna, Austria. A worker presumably from the original nest series in the Peabody Museum of Natural History. (For more definite information see discussion elsewhere under *lucidus*.)

Slaves.—*Formica pallidefulva nitidiventris* Emery, *F. pallidefulva schaufussi* Mayr, *F. pallidefulva schaufussi incerta* Emery.

Polyergus lucidus longicornis, new subspecies

Worker.—Length 7 mm.

Head 1.06 times as long as broad, cheeks slightly concave, sides of head converging behind the eyes, posterior border weakly emarginate. Eye rather strongly convex, prominent, longer than broad, placed more than its greatest diameter from the base of the mandible. Antennal scape unusually long, 1.51 times the length of the interocular distance, gradually enlarging toward the apex but not forming a suddenly dilated, prominent club as with *breviceps*. Frontal carinae short. Frontal area subtriangular, not strongly defined. Ocelli extremely small. Clypeus at least twice as broad as long, subcarinate, the anterior border with a broad but shallow median emargination. Thorax with distinct promesonotal suture. In profile, dorsal surface of mesonotum extending from the promesonotal suture to the prominent mesoepinotal impression in a descending, almost unbroken line. A large and protuberant spiracle on each side of the mesoepinotal impression and also one on each side of the epinotum. Base of epinotum meeting the declivity in a bluntly rounded angle which is greater than a right angle. Petiole erect, thick anteroposteriorly, more convex anteriorly than posteriorly, with a blunt, subtruncate, superior border. Gaster oblong, rounded at the base.

Head and thorax subopaque, with a grayish sheen in most lights.

Erect, yellowish hairs on mandibles, clypeus, gula, occipital lobes, pronotum, prosternum, epinotum, coxae, trochanters, flexor surface of each leg, petiole, and gaster. Pubescence on body so fine, appressed, and sparse as to be scarcely noticeable; on appendages denser and more apparent; on gaster sparse and not concealing the surface in any light.

Body dull reddish brown, with the third, fourth, and fifth gastric segments distinctly infuscated. Legs scarcely darker than the body.

Described from a holotype and nine paratype workers collected by the author on May 3, 1941, at Florence, S. C. These have been placed in the United States National Museum collection and are recorded under U.S.N.M. No. 57661. They were collected from a shallow nest in the light loamy soil of open woods. The colony was apparently very small, containing only a few dozen individuals.

Some of the paratypes differ from the holotype in having more extensive infuscation of the gaster, this sometimes embracing the posterior border of each of the four apical segments. The legs are also slightly darker in some specimens. The length ranges from approximately 6 to 7 mm. The scape varies in length from 1.45 to 1.56 times the interocular distance.

This new subspecies can be distinguished from the other forms of *Polyergus* by the unusually long antennal scape which gradually enlarges toward the apex without forming a suddenly dilated club; erect hairs on the occipital lobes; the grayish sheen of the subopaque head and thorax; the weakly concave cheeks; dull reddish-brown color. Apparently Florence is the most southern point in the Southeastern States where a colony of *lucidus* or any of its forms has been observed. However, the author has seen a single winged female of *lucidus*, either subspecies *longicornis* or a closely allied form, that was collected at Waycross, Ga., on October 5, 1938, by Paul W. Oman.

Slave.—Formica pallidefulva schaufussi Mayr.

POLYERGUS LUCIDUS MONTIVAGUS Wheeler

Polyergus lucidus montivagus Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:419, worker, female, male; 1917, Amer. Acad. Arts and Sci. Proc. **52**:555.

The worker of *montivagus* is approximately the same length as that of *lucidus*. The scape is from 1.3 to 1.4 times the length of the interocular distance. The worker is distinguished from that of *lucidus* by its paler, more yellowish-red color; the dull, or at least less shining, surface of the head and thorax; the lack or weakness of infuscation at the apex of the gaster; and the sparsity of the pilosity. The occipital lobes are without hairs or have only one or two each. A cotype worker examined by the author has erect hairs on the mandibles, clypeus, gula, occipital lobes, epinotum, coxae, trochanters, flexor surface of each leg, petiole and gaster; there is one hair on one occipital lobe and two on the other; the epinotum bears a single hair. In his original description Wheeler mentions "the complete or nearly complete absence of erect hairs on the posterior corners of the head, the smaller number of hairs on the gula" but he does not remark on the amount of pilosity on other parts of the body and appendages.

Type locality.—Canyons about Colorado City and Manitou, Colo., W. M. Wheeler.

Other localities.—None.

Cotypes in the Museum of Comparative Zoology, Cambridge, Mass., and the United States National Museum, Washington, D. C.

Slave.—Formica pallidefulva schaufussi near var. *incerta* Emery.

POLYERGUS RUFESCENS BREVICEPS Emery

Polyergus rufescens breviceps Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:666, worker; Wheeler, 1916, N. Y. Ent. Soc. Jour. **24**:107-118 (slave raids); 1917, Amer. Acad. Arts and Sci. Proc. **52**:555; 1926, Ants, 2d ed., pp. 475-477; Smith, 1928, N. Y. Ent. Soc. Jour. **36**:329-333 (slave raids); Cole, 1936, Canad. Ent. **68**:38; 1942, Amer. Midl. Nat. **28**:385; Mallis, 1941, South. Calif. Acad. Sci. Bul. **40**:82; Morris, 1943, Ind. Acad. Sci. Proc. **52**:220; Buren, 1944, Iowa State Col. Jour. Sci. **18**:310 (key to workers); Gregg, 1944, Ent. Soc. Amer. Ann. **37**:476 (key to workers).

Worker.—Length 6 mm.

Head measured through its greatest breadth as wide as long, sides convergent anteriorly before the eyes and posteriorly behind the eyes, posterior border almost imperceptibly emarginate. Ocelli extremely small, arranged in a triangle with the anterior ocellus almost situated on an imaginary line connecting the posterior borders of the eyes. Frontal carinae short, posteriorly divergent. Antennal scape short, slightly shorter than the interocular distance, with a rather abrupt, strong, clublike enlargement toward the apex. Eye prominent but not strongly convex, longer than wide, situated more than its greatest diameter from the base of the mandible. Frontal area triangular. Clypeus more than twice as broad as long, convex posteriorly but not carinate. Mandible falcate, depressed, with the inner border minutely serrate. Thorax short, stout. In profile, pronotum highest in its posterior half. Promesonotal suture distinct. Mesonotum not strongly convex, its outline forming a gentle arch from the promesonotal suture to the mesoepinotal impression. A conspicuous spiracle in the impression and one also on the side of the epinotum. Base of epinotum convex, the base and declivity meeting to form a broadly rounded angle. Petiole erect, more convex anteriorly than posteriorly, thick anteroposteriorly, with a transversely rounded, blunt, superior border. Gaster oblong, rounded at the base.

Erect, yellowish hairs on mandibles, clypeus, flexor surface of each tibia and tarsus, petiole and gaster. Pubescence extremely fine and appressed, most noticeable on legs and gaster, where in certain lights at least, it gives the surface a subopaque effect. Mandibles smooth and shining. Head and thorax with sculpturing so delicate and granular that it cannot be seen very clearly with the low power of a binocular.

Color reddish.

Described from a specimen bearing the labels, "Hill City, S. Dak., Jun. '90, No. 142, T. Pergande collection." This individual is believed to belong to the original series from which type specimens were described. The worker lacks the erect hairs which are present on the pronotum, mesonotum, coxae, and tibiae of other individuals from the same locality. In these specimens, also, the petiole has an emarginate or subtruncate superior border.

Specimens from different localities vary in size, shape, pilosity, and degree of sculpturing. Workers range from 5 to 7 mm. in length. The head is often slightly longer than wide. The eye weakly to moderately convex. In some specimens the mesonotum is weakly convex, in others more strongly

convex. The base of the epinotum may meet the declivity in a very broadly rounded angle or in nearly a right angle. The petiolar border is usually transversely rounded but it is sometimes subtruncate. Erect hairs are usually present on the mandibles, clypeus, pronotum, coxae, trochanters, flexor surface of femora, tibiae and tarsi, epinotum, petiole and gaster. Sometimes hairs occur on the gula and mesonotum, but they are only exceptionally found on the occipital lobes. The sculpturing of the head and thorax is so variable that in some specimens these parts are more or less shining, whereas on other specimens they are more subopaque. The head is often more shining than the thorax. The gaster is normally without any well-defined degree of infuscation such as is seen in *lucidus* and some of its forms.

The best characters for distinguishing *breviceps* are given in the key. The worker is superficially similar to that of *laeviceps* and *umbratus*. From *laeviceps* it may be distinguished by its less shining head and somewhat larger body, and from *umbratus* by its color.

P. rufescens breviceps is one of the most common and widely distributed forms of *Polyergus* in the United States. It ranges over the Western and Midwestern States and has been found as far east as Illinois and Indiana. In the Midwest its distribution is overlapped by that of *lucidus*, a distinct eastern form.

Original localities.—Hill City, S. Dak., Titus Ulke (?), and Breckenridge, Colo., P. J. Schmitt (?).

Other localities—INDIANA: Crawford County, W. S. B.; Hammond, M. T. ILLINOIS: Harvey and Mokena, A. S. W. and R. E. G.; Urbana, M. R. S. and W. V. B.; Decatur, F. H. B.; Algonquin, W. A. N.; Galesburg, M. C. T.; Cook County, M. T. IOWA: Ames and Sioux City, C. N. A.; Clinton, Des Moines and Davenport, W. F. B. NEBRASKA: Schuyler, O. S. B. KANSAS: Osage City, A. C. B.; Lawrence, C. H. C.; Baldwin, J. C. B. MONTANA: Elkhorn Mountains, W. M. M. COLORADO: Cheyenne Canyon near Colorado Springs and Florissant Canyon west of Pikes Peak, W. M. W.; Estes Park, A. C. B.; Mesa S. Pedro in Castilla County, B. R.; Ute Pass, W. M. W.; Glamosa and Durango, R. E. G. and E. V. G. NEW MEXICO: Old Pecos Pueblo, T. D. A. C. IDAHO: Twin Falls, A. C. C., Jr. UTAH: Salt Lake County and Green Canyon in Cache County, G. F. K.; Logan, A. C. B. and E. S. G. T.; Ritchfield, J. A. R.; Chester, D. M. R. ARIZONA: Apache Camp, S. Catalina Mountains and Fort Grant, Pinaleno Mountains, W. M. W. WASHINGTON: Pullman and Wawawai, W. M. M.; Dayton, S. H. L. OREGON: Monroe, collector Finley. CALIFORNIA: Fallen Leaf Lake and Glen Alpine near Lake Tahoe, W. M. W.; Santa Cruz, H. H.; Kern Lake, J. C. B.; Soquel Road in Madera County, A. M.

Cotypes in the Emery collection of the Museo Civico, Genoa, Italy. Specimens presumably from the original nest series in the United States National Museum, Washington, D. C. (For more definite information see discussion elsewhere under *breviceps*.)

Slaves.—Formica fusca var. *argentea* Wheeler, *F. fusca* var. *subsericea* Say, *F. fusca* var. *neorufibarbis* Emery, *F. fusca* var. *subaenescens* Emery, *F. fusca* Linnaeus, var. *F. cinerea* var. *neocinerea* Wheeler.

POLYERGUS RUFESCENS BICOLOR Wasmann

Polyergus rufescens bicolor Wasmann, 1901, Allg. Ztschr. f. Ent. **6**:369, worker, female, male; 1915, Gesellschaftsleben d. Ameisen **1**:278, pl. 3, figs. 3-8, worker, female, male; Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:556; 1926, Ants, 2d ed., pp. 477-482; Buren, 1944, Iowa State Col. Jour. Sci. **18**:310 (key to workers).

Worker.—Length 5-7 mm.

Head almost exactly as wide as long. Antennal scape shorter than the interocular distance. Eye moderately convex but not so convex as in *lucidus*. This subspecies is characterized mainly by sculpture, color, and pilosity. The surface of the head and thorax is dull and subopaque in almost all lights. The head, however, is sometimes more shining than the thorax, and the mandibles are always smooth and shining. The gaster is subopaque in most lights. The head and thorax are concolorous, varying from reddish brown to very dark reddish brown. The antennal scapes, legs, petiole, and gaster appear blackish to black depending upon the nature of the light. The contrast in color between the head and thorax and the gaster gives the body a bicolored effect. Pilosity is sparse; erect hairs are apparently always present on the clypeus, mandibles, petiole, gaster, and flexor surface of each tibia and tarsus, but are absent from the gula, occipital lobes, and flexor surfaces of the femora. Erect hairs may be absent from the dorsal surface of the thorax, or there may be only one or two hairs on one, two, or all three of the thoracic segments. The pubescence is fine, dense, and appressed on the petiole, legs, and gaster, but more apparent in some lights than others; the pubescence on the head and thorax is scarcely perceptible under the low power of a binocular.

Old individuals have a tendency to fade to such an extent that the original colors are lost. Cotype specimens examined by the author have a reddish-brown instead of a blackish or black gaster, but the color of the gaster is still somewhat darker than that of the head and thorax. Most individuals, regardless of age, have the posterior border of each segment darker than the remainder of the segment. It is difficult to determine whether this is natural or is due to the effect produced by the overlapping of the gastric segments. With freshly collected individuals one has little difficulty in recognizing this subspecies.

The exact range of *bicolor* has not been definitely determined. Specimens have been collected from Michigan to Montana and southward to Iowa and Illinois. The ant appears to be strictly a northern form.

Type locality.—Prairie du Chien, Wis., H. Muckermann.

Other localities.—MICHIGAN: Crystal Falls, A. C. C., Jr. MINNESOTA: Akeley and Jenkins, W. F. B.; Saganaga Lake, R. E. G. ILLINOIS: Rockford, W. M. W. IOWA: Backbone State Park, W. F. B. MONTANA: Yellow Bay and Flathead Lake, C. C. A.

Cotypes in the Wasmann collection at Maastricht, Holland. Five workers and one male, labeled cotypes, in the Wm. M. Mann collection at the United States National Museum, Washington, D. C.

Slave.—*Formica fusca* var. *subaenescens* Emery.

POLYERGUS RUFESCENS LAEVICEPS Wheeler

Polyergus rufescens laeviceps Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:420, worker; 1917, Amer. Acad. Arts and Sci. Proc. **52**:556; Mallis, 1941, South. Calif. Acad. Sci. Bul. **40**:82.

Worker.—Length 4-5.5 mm.

This subspecies is characterized mainly by its size, sculpture, pilosity, and color. The worker is smaller than that of *rufescens breviceps*. The head especially is smooth and shining in all lights, and the thorax is rather shining, particularly the propleura. Erect hairs are present on the same positions of the body and legs as in *breviceps*, and in addition there are hairs on the occipital lobes and gula, and sometimes a few on the mesonotum. The color of the body is not materially different from that of *breviceps* except that gastric segments 2 through 5 are more or less infuscated. Wheeler indicates in the original description that the scape has a shorter and more abrupt clublike enlargement than that of *breviceps* and *bicolor*.

Type locality.—Mount Tamalpais, near San Francisco, Calif., W. M. Wheeler.

Other locality.—Laws, Calif., A. Wetmore.

Cotypes in the Museum of Comparative Zoology, Cambridge, Mass., and the United States National Museum, Washington, D. C.

Slave.—*Formica subpolita* Mayr.

POLYERGUS RUFESCENS BREVICEPS UMBRATUS Wheeler

Polyergus rufescens breviceps umbratus Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:419, worker; 1917, Amer. Acad. Arts and Sci. Proc. **52**:555; Mallis, 1941, South. Calif. Acad. Sci. Bul. **40**:82.

Worker.—Length 5.7-6 mm.

This variety is characterized by size and color. The body of large workers is robust, especially the thorax. Color a sordid, reddish brown with the gaster apparently lacking infuscation. The antennal scape is shorter than the interocular distance. The eye, although moderately convex, is not so convex as in *lucidus* and its forms. Pubescence is rather dense on all parts of the body except the head, which is shining in some lights and subopaque in others. Hairs are present on the mandibles, clypeus, gula, pronotum, epinotum, coxae, trochanters, flexor surface of each tibia and tarsus, petiole, and gaster, but lacking on the occipital lobes and mesonotum.

Except for color this ant closely resembles large workers of *breviceps*.

Type locality.—Brookdale, Calif., Harold Heath.

Other localities.—None.

Cotypes in the Museum of Comparative Zoology, Cambridge, Mass., and the United States National Museum, Washington, D. C.

Slave.—A small variety of *Formica fusca* Linnaeus near var. *argentea* Wheeler.

POLYERGUS RUFESCENS BREVICEPS FUSCIVENTRIS Wheeler

Polyergus rufescens breviceps fusciventris Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:555, worker.

"*Worker.*—Length 4 mm.

"Differing from the typical *breviceps* in its smaller size, more opaque and more coarsely shagreened surface, in having the petiolar node distinctly shorter and more compressed anteroposteriorly and the posterior 2/5 of the first gastric segment and the whole of the succeeding segments except the anal region, fuscous."

Wheeler considers this variety transitional to the subspecies *bicolor*. The author has not been able to study the holotype.

Type locality.—Half Way House on Pikes Peak, Colo., T. D. A. Cockerell.

Other locality.—Treesbank, southern Manitoba, Canada, C. G. Hewitt.

Holotype in the Museum of Comparative Zoology, Cambridge, Mass.

Slave.—*Formica fusca* Linnaeus.

POLYERGUS RUFESCENS BREVICEPS SILVESTRII Santschi

Polyergus rufesecns breviceps silvestrii Santschi, 1909, Soc. Ent. Ital. Bol. **41**:7, worker, male; Mallis, 1941, South. Calif. Acad. Sci. Bul. **40**:82.

"Diffère du *breviceps* par la tête plus large et plus échancrée en arrière et la couleur plus foncée. Le ♂ entièrement noir a les ailes très enfumées de noirâtre. (Comparé avec un type de Mr. Pergande communiqué par Mr. Forel.)"

Type locality.—Yosemite, Calif., F. Silvestri.

Other localities.—None.

Location of cotypes not known.

Slaves.—Species not recorded.

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE,
AGRICULTURAL RESEARCH ADMINISTRATION,
UNITED STATES DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

The Amphibians and Reptiles of North Dakota

George C. Wheeler

Systematic List[1]

Class Amphibia
- Order Caudata
  - Family Ambystomidae
    1. *Ambystoma tigrinum tigrinum* (Green)
    2. *Ambystoma tigrinum diaboli* Dunn
    3. *Ambystoma tigrinum melanostictum* (Baird)
- Order Salientia
  - Family Scaphiopodidae
    4. *Scaphiopus bombifrons* Cope
  - Family Bufonidae
    5. *Bufo cognatus* Say
    6. *Bufo hemiophrys* Cope
    7. *Bufo woodhousii woodhousii* Girard
  - Family Hylidae
    8. *Pseudacris nigrita septentrionalis* (Boulenger)
  - Family Ranidae
    9. *Rana catesbeiana* Shaw
    10. *Rana pipiens* Schreber
    11. *Rana sylvatica cantabrigensis* Baird

Class Reptilia
- Order Squamata
  - Family Iguanidae
    1. *Phrynosoma brevirostre* (Girard)
  - Family Scincidae
    2. *Eumeces septentrionalis septentrionalis* (Baird)
  - Family Colubridae
    3. *Heterodon contortrix contortrix* (Linnaeus)
    4. *Heterodon nasicus nasicus* (Baird & Girard)
    5. *Opheodrys vernalis blanchardi* Grobman
    6. *Coluber constrictor flaviventris* (Say)
    7. *Pituophis sayi sayi* (Schlegel)
    8. *Storeria occipitomaculata occipitomaculata* (Storer)
    9. *Thamnophis radix* (Baird & Girard)
    10. *Thamnophis sauritus proximus* (Say)
    11. *Thamnophis sirtalis parietalis* (Say)
  - Family Crotalidae
    12. *Crotalus viridis viridis* Rafinesque.
- Order Testudinata
  - Family Chelydridae
    13. *Chelydra serpentina serpentina* (Linnaeus)
  - Family Testudinidae
    14. *Chrysemys bellii bellii* (Gray)

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1 Sequence after Stejneger & Barbour, 1943.

Zoogeographical Comments

The amphibian and reptilian faunas of North Dakota may be characterized as depauperate. The impoverishment is due in part to high latitude and in part to low rainfall. That such are the causes is evidenced by a comparison with the faunas of the adjoining states of Minnesota on the east and South Dakota on the south. North Dakota can muster only 11 forms (= species and subspecies) in the Amphibia and 14 in the Reptilia, while Minnesota tallies 20 and 30 respectively and South Dakota 11 and 26. To make the data comparable, however, the Minnesota faunas should be divided into northern and southern portions with an eastward extension of the North-South Dakota boundary as the line of demarcation.

To ascertain the effects of latitude (i. e., temperature) one may compare North Dakota with South Dakota. Both states extend through the same range of longitude and have the same north-south dimensions and therefore the same area, the rainfall conditions are similar throughout the length of both. The great difference lies in the average annual temperature: about 35° F. in northern North Dakota, about 43° F. at the boundary between the two states and about 48° F. in southern South Dakota. South Dakota has 37 amphibians and reptiles against 25 for North Dakota.

The effect of rainfall is shown by comparing North Dakota with northern Minnesota. In North Dakota the average annual rainfall decreases from about 20 inches in the Red River Valley to about 10 inches on the western border, while that of northern Minnesota increases from about 20 inches in the Red River Valley to about 30 inches in the extreme eastern part. The temperature gradient is approximately the same in both. North Dakota has only 25 forms, while northern Minnesota has 34.

Further confirmation is to be found in southern Minnesota, where there is a summation of the effects of lower latitude and higher rainfall. This region, although much smaller in area, has a combined total of 48 forms.

The conclusions in the preceding paragraphs are based upon the data in the following table:

	North Dakota		Minnesota (northern)		Minnesota (southern)		South Dakota		Minnesota	
Amphibia		11		16		18		11		20
Caudata	3		5		6		3		6	
Salientia	8		11		12		8		14	
Reptilia		14		18		30		26		30
Lizards	2		1		3		6		3	
Snakes	10		12		19		15		19	
Turtles	2		5		8		5		8	
Totals		25		34		48		37		50

Do these two factors of latitude (or temperature) and rainfall have differential effects on amphibians and reptiles? Comparing South Dakota with North Dakota one finds that the size of the amphibian fauna is the same, but that the reptilian fauna decreases 46% from south to north. Similarly a southern to northern comparison within Minnesota shows an amphibian de-

crease of 11% and a reptilian decrease of 40%. By contrast, an east to west comparison in northern Minnesota with North Dakota shows a decrease of 31% in amphibian forms and 22% in reptiles. Southern Minnesota to South Dakota shows a decrease of 39% in amphibians and 13% in reptiles. It seems therefore that a decrease in average annual rainfall is more unfavorable to amphibians than to reptiles, while a decrease in average annual temperature is more unfavorable to reptiles than to amphibians. In other words, the impoverishment of the amphibian fauna of North Dakota is attributable more to the aridity than to the cold climate; the impoverishment of the reptilian fauna is attributable more to the cold climate than to aridity.

The amphibian and reptilian faunas of North Dakota may be divided (rather roughly) into the following components on the basis of the known ranges:

Central Canadian forms: *Ambystoma tigrinum diaboli, Bufo hemiophrys.*

Northwestern forms: *Ambystoma tigrinum melanostictum, Pseudacris nigrita septentrionalis, Rana sylvatica cantabrigensis.*

Great Plains forms: *Scaphiopus bombifrons, Bufo cognatus, Bufo woodhousii woodhousii, Phrynosoma brevirostre, Heterodon nasicus nasicus, Crotalus viridis viridis.*

Eastern forms: *Ambystoma tigrinum tigrinum, Rana catesbeiana, Rana pipiens, Heterodon contortrix contortrix, Storeria occipitomaculata occipitomaculata, Chelydra serpentina serpentina.*

Central States forms: *Eumeces septentrionalis septentrionalis, Opheodrys vernalis blanchardi, Coluber constrictor flaviventris, Pituophis sayi sayi, Thamnophis radix, Thamnophis sauritus proximus, Thamnophis sirtalis parietalis, Chrysemys bellii bellii.*

These components may be tabulated statistically as follows:

	Central Canadian	Northwestern	Great Plains	Eastern	Central States
Amphibia	2	3	3	3	--
Caudata	1	1	--	1	--
Salientia	1	2	3	2	--
Reptilia	--	--	3	3	8
Lizards	--	--	1	--	1
Snakes	--	--	2	2	6
Turtles	--	--	--	1	1
Totals	2	3	6	6	8

The Central Canadian, Northwestern and Great Plains components might well be lumped into a "western" category. If this is done, then the amphibian fauna is seen to be predominantly western. Among the reptiles, however, we can place the Central States majority in the middle, balance the Great Plains against the East and conclude that North Dakota is a transitional region. This transitional status also exists in other groups of organisms.

A study of the ranges of North Dakota amphibians and reptiles *within* the state, however, reveals practically nothing. In fact, about the only conclusion that can be safely drawn is that more collecting should be done in the state.

Historical Notes

The first records of North Dakota amphibians and reptiles are probably the observations of Captain Meriwether Lewis made in 1805 (Thwaites, 1904, p. 257 & 312). I have quoted them below in the annotations on the leopard frog and the prairie rattlesnake.

The next would doubtless be Bradbury's reference (1819, p. 147) to rattlesnakes collected in 1811. This is also quoted below.

Audubon visited the territory that is now North Dakota in 1843. Referring to the Badlands ("Mauvaises Terres") he states that "venomous snakes are also found here. I saw myself only one copperhead and a common garter snake." (Audubon, 1898, p. 151). The name "copperhead" is sometimes locally applied to the harmless hog-nosed snakes (Heterodon), which are generally reputed to be venomous by laymen. Since two species of Heterodon occur in western North Dakota it is safe to assume that Audubon was referring to this genus.

In 1873 Dr. J. A. Allen accompanied the Northern Pacific Railway Expedition as naturalist. "The route taken by the Expedition may be briefly indicated as follows: Starting from Fort Rice, on the Missouri River (a point a little to the north of the geographical centre of Dakota), our course was thence nearly due west to the Yellowstone River, in Montana Territory, which we struck a few miles above the mouth of Glendive Creek . . . Reptilian life is extremely scarce throughout the region traversed by the Expedition, there being but two species very numerously represented, or very generally dispersed. These are the *Caudisonia confluenta* [=*Crotalus viridis*] and the *Phrynosoma Douglassi* [*Ph. brevirostre*]. The first not only outnumbers all the other Ophidians, but all the other reptiles, excluding the *Phrynosoma Douglassi*, which may possibly exceed in numbers the *Caudisonia confluenta*. . . . As would be anticipated from the great aridity of the climate, the Batrachians are very sparsely represented in the district traversed by the Expedition. The *Rana halecina* [=*R. pipiens*] is by far the most common species, but is yet comparatively scarce, and, with *Bufo columbiensis* [probably *B. woodhousii*]forms the only representative of the class that can be regarded as at all frequent." (Allen, 1874, p. 33, 68 & 70). Allen's published list (1874) included two amphibians and five reptiles from North Dakota.

In the same year (1873) Dr. Elliott Coues, as naturalist for the United States Northern Boundary Commission, collected along the international boundary. He recorded (Coues and Yarrow, 1878) three amphibians and two reptiles from North Dakota.

About 1919 the Museum of Zoology of the University of Michigan entered into a cooperative arrangement with the Biological Station of the University of North Dakota for a survey of the fauna of the latter state. Collections were made during several summers. Most of the amphibians and reptiles were collected by Miss Crystal Thompson and the specimens are now in the Museum. Most of the records are published here for the first time.

Among the 25 forms of amphibians and reptiles listed for North Dakota there are three type localities. "Fort Union, on the Missouri River" is one of the type localities for *Scaphiopus bombifrons* Cope (1863). *Bufo*

hemiophrys was described by Cope in 1886 from specimens collected at Pembina and in the Turtle Mountains. Dunn in 1940 designated Devils Lake as the type locality for the subspecies *diaboli* of *Ambystoma tigrinum.*

This present study completes the pioneer survey of the vertebrates of North Dakota. The lampreys and fishes were surveyed by T. L. Hankinson (1928), the birds by Norman A. Wood[2] and the mammals by Vernon Bailey.[3]

Geographical Notes

A number of localities recorded in this study are difficult or impossible to locate on any ordinary maps. I am therefore explaining the locations for the benefit of students of distribution. All mileages are approximate.

Adams County: I have not been able to locate Cook on any map, but an Atlas of 1913 lists Lemmon, South Dakota as its post office. It is probably near the state line not far from Lemmon.

Benson County: Wood Lake lies across the Benson-Eddy boundary 12 miles west of the Nelson County line. Court Lake (= Lake Minniwastena) is ten miles south of the city of Devils Lake. Spring Lake is one mile north of Tokio. Tokio Lake is one mile southeast of Tokio.

Billings County: Peaceful Valley Ranch is in T.140, R.102 and on the Little Missouri River about three miles north of Medora. The Petrified Forest is in T.141, R.102; it can be located on a map by measuring 4½ miles northward from Medora and then 2½ miles westward. T.144, R.102 is in the northwestern corner of the county.

Eddy County: Wood Lake lies across the Benson-Eddy boundary 12 miles west of the Nelson County line. Monahan's Ranch is on the Sheyenne River near Warwick and 18 miles northeast of New Rockford.

Griggs County: Red Willow Lake is near the northwestern corner of the county; it is a mile from the northern boundary and six miles from the western boundary.

Lakes. Most of the lakes referred to are in the Turtle Mountains or in the Devils Lake region. Some I have not been able to locate at all, others only after prolonged searching. In the Turtle Mountains there are hundreds of lakes most of which are unnamed, at least on maps. Doubtless many of them have local names; some of the localities named by collectors are apparently in this category. In some instances the same lake is known by more than one name. In the Devils Lake region the same situation prevails but has been further complicated by the shrinking of Devils Lake itself. I have found the following maps useful: Plate 20 in an article by R. T. Young, *Annals of the Missouri Botanical Garden* **10**, pp. 385-392, 1923; the state map published by the United States Department of the Interior (General

2 A preliminary survey of the bird life of North Dakota. Univ. Michigan Mus. Zool. Misc. Publ. No. **10**:1-96, 1923.

3 A biological survey of North Dakota. I. Physiography and life zones. II. The mammals. U. S. Dept. Agric., Bur. Biol. Surv., N. Amer. Fauna No. **49**:1-226, 1926.

Land Office) in 1918; United States Geological Survey topographic maps of the Dunseith, Lake Upsilon, Grahams Island, Devils Lake, Tokio and Hamar quadrangles.

McHenry County: Round Lake is near the southeastern corner of the county.

McKenzie County: Goodall is on the west bank of the Missouri River opposite Sanish.

McLean County: Strawberry Lake is near the northwestern corner of the county.

Morton County: The old Fort A. Lincoln, which is five miles south of Mandan is not to be confused with the modern Fort Lincoln, which is just south of Bismarck.

Ramsey County: Odessa Narrows was the strait which formerly connected the easternmost bay (now called East Devils Lake) with the main body of Devils Lake; it was six miles south of Crary. Mauvaise Coulee formerly connected the northwestern arm of Devils Lake with Lake Irvine; it crosses the Ramsey-Benson boundary a short distance south of Churchs Ferry.

Rolette County: Lake Upsilon is also called Fish Lake on some maps. There is, however, on the Geological Survey topographic map a Fish Lake six miles southeast of Lake Upsilon.

Turtle Mountains: This name is applied to the high, rough, plateau-like area in the northeastern part of Bottineau County and the northwestern part of Rolette County and extending across the international boundary into Canada. It is about 40 miles long and 25 miles wide and rises 400 to 600 feet above the surrounding plain. In early accounts the area is designated as "Turtle Mountain."

Williams County: Fort Union is on the north bank of the Missouri River on the boundary between Montana and North Dakota. Grinnell is a mile and a half from the eastern boundary of the county and five miles north of the Missouri River; an atlas of 1913 placed it across the line in Mountrail County.

Key to the Amphibians and Reptiles of North Dakota

*(Forms marked * have not been recorded from this state but may reasonably be expected to occur here).*

1. Skin smooth and moist (in frogs and salamanders) or warty and rather dry (in toads); no covering of scales or bony armor ..... Class Amphibia 2
   Skin dry; body covered with scales (in lizards and snakes) or encased in bony armor which is usually covered with thin horny plates (in turtles) ..... Class Reptilia 19

2. With a tail 3
   Without a tail ..... Adults of Order Salienta 8

3. Body very short and plump; jaws furnished with transverse, horny, finely toothed ridges; tadpoles ..... Larvae of Order Salientia

Body elongate; jaws without horny ridges ..... Order Caudata 4
4. External gills present 5
External gills absent 6
5. With four blunt toes on hind feet ..... *Necturus[4] maculosus maculosus*
With five pointed toes on the hind feet ..... Larvae of Ambystoma
6. Ground color yellow with black blotches ..... *Ambystoma tigrinum diaboli*
Ground color dark 7
7. Ground color black with yellow blotches ..... *Ambystoma tigrinum tigrinum*
Dark ground color reduced to a network ..... *Ambystoma tigrinum melanostictum*
8. Parotoid glands and cranial crests present; toads 9
Parotoid glands and cranial crests absent 12
9. Interorbital crests swollen and fused into one wide rounded elevation, with or without a central groove; postorbital crests incomplete or absent; ventral surface spotted ..... *Bufo hemiophrys*
Interorbital crests distinct; postorbital crests complete 10
10. Interorbital crests thick and widely divergent posteriorly from a bony elevation above and between the nostrils; belly without spots ..... *Bufo cognatus*
Interorbital crests narrow and nearly parallel 11
11. Ventral surface spotted ..... **Bufo americanus*
Ventral surface unspotted or with only one median pectoral spot ..... *Bufo woodhousii woodhousii*
12. Pupil of eye vertical when contracted; inner sole tubercle large, with extensive horny cutting edge ..... *Scaphiopus bombifrons*
Pupil of eye round; no horny cutting edge on inner sole tubercle 13
13. Digits with adhesive disks at the tips; skin of belly granular; tree frogs 14
Digits without adhesive disks; skin of belly not granular; frogs 17
14. Adhesive disks not wider than digits 15
Adhesive disks distinctly wider than digits 16
15. Skin warty; toes almost fully webbed ..... **Acris crepitans*
Skin smooth or finely granular; toes webbed only at base; 3 dark longitudinal stripes on back ..... *Pseudacris nigrita septentrionalis*
16. Color cream to brown; dark pattern on back in the form of an X; fingers without webs; posterior surface of thighs not orange (when alive) ..... **Hyla crucifer*
Color usually gray to bright green, sometimes brown; dark pattern on back not in the form of an X; fingers partly webbed; posterior surface of thighs orange (when living) ..... **Hyla versicolor*
17. Dorsolateral ridges absent ..... *Rana catesbeiana*
Dorsolateral ridges present 18
18. With large rounded or elongate spots on the back between the dorsolateral ridges ..... *Rana pipiens*
Without large spots on the back ..... *Rana sylvatica cantabrigensis*
19. Body encased in bony armor which is usually covered with thin horny plates; turtles ..... Order Chelonia 33
Body covered with scales; no bony armor; lizards and snakes ..... Order Squamata 20
20. Limbs present; lizards 21
Limbs absent; snakes 22

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4 Bishop (1943, p. 28) includes the eastern tier of counties in the range of this salamander. Telford and Stevens (1942, p. 31) refer to an unpublished report that it is "a common inhabitant of our artificial lakes." I have not been able to secure a copy of the unpublished report; there are no published records; I have found no specimens collected in the state. It therefore seems advisable to omit this form from the present list.

21. Body broad and flat; head with spines or horns ..... *Phrynosoma brevirostre*
Body long and slender; head without spines or horns ..... *Eumeces septentrionalis septentrionalis*

22. Tail with a rattle at the tip ..... *Crotalus viridis viridis*
Tail without a rattle 23

23. Some or all of the dorsal scales keeled 24
Dorsal scales smooth 31

24. Anal plate divided 25
Anal plate entire 27

25. Rostral plate turned up in front and keeled above 26
Rostral plate not turned up in front or keeled above; belly red (when alive) ..... *Storeria occipitomaculata occipitomaculata*

26. Snout (in profile) concave above; under surface of tail as dark as belly ..... *Heterodon nasicus nasicus*
Snout (in profile) straight above; under surface of tail lighter than belly ..... *Heterodon contortrix contortrix*

27. Scales in 29 to 35 rows ..... *Pituophis sayi sayi*
Scales in 23 rows or fewer 28

28. Lateral stripe on second and third rows of scales 29
Lateral stripe on third and fourth rows of scales 30

29. Skin between scales and spaces between dark spots and bright red ..... *Thamnophis sirtalis parietalis*
Skin between scales and light spaces between dark spots not red ..... **Thamnophis sirtalis sirtalis*

30. Tail more than one-fourth the total length ..... *Thamnophis sauritus proximus*
Tail less than one-fourth the total length ..... *Thamnophis radix*

31. Color bright green, sometimes brownish ..... *Opheodrys vernalis blanchardi*
Color not bright green or brown 32

32. Back uniformly bluish, greenish blue, dark gray or olive gray; belly yellow ..... *Coluber constrictor flaviventris* (adult)
Back with prominent dark blotches on a lighter background ..... *Coluber constrictor flaviventris* (young)

33. Armor covered by leathery skin ..... **Amyda spinifera spinifera*[5]
Armor covered by thin horny plates 34

34. Tail almost as long as carapace (or longer) and furnished with a dorsal row of horny tubercles ..... *Chelydra serpentina serpentina*
Tail much shorter than carapace and without tubercles ..... *Chrysemys bellii bellii*

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[5] Both Conant (1938) and Breckenridge (1944) include the extreme southwestern part of North Dakota in their maps for this turtle, but I have found no records for the state.

North Dakota; Crystal Thompson, Curator of Visual Education, University Museums, University of Michigan. I am especially appreciative of the aid rendered by Mrs. Gaige.

The location of the specimens referred to in my annotated lists is indicated by the following abbreviations: UMMZ=Museum of Zoology, University of Michigan; USNM=United States National Museum; UMNH= Museum of Natural History, University of Minnesota; UND=Department of Biology, University of North Dakota.

Annotated List of the Amphibians of North Dakota

1. AMBYSTOMA TIGRINUM TIGRINUM (Green)

Eastern Tiger Salamander—North Dakotans usually call this salamander a "lizard." It is the common eastern form and is probably found only in the extreme eastern part of the state, since Minnesota is supposed to be the limit of its range.

NORTH DAKOTA RECORDS[6].—*Grand Forks County:* Grand Forks, February 1928, collected in basement of dwelling by G. C. Wheeler (UND); Grand Forks, collected by G. C. Wheeler, September 19 and October 13, 1945 (UND).

2. AMBYSTOMA TIGRINUM DIABOLI Dunn

Devils Lake Tiger Salamander, Yellow Tiger Salamander—The type locality for this subspecies is Devils Lake, North Dakota. The type specimen is a male in the Museum of Zoology at the University of Michigan (No. 50156); Dunn says (1940, p. 156) it is the largest transformed specimen he has seen; its total length is 287 mm. The larvae of this subspecies are known to attain a length of 312 mm. and are often neotenous (Dunn, 1940, p. 155 & 156). Both larvae and adults inhabit fresh water lakes. They also occur in Devils Lake, which is very brackish, but do not breed there (Young, 1924, p. 99). Apparently *diaboli* breeds only in fresh water.

The earliest records found for the state are in Coues & Yarrow (1878, p. 291) under the name of *A. mavortium* as follows: 1045, Pembina, June 24, 1873; 1057, Pembina, June 28, 1873; 1071, Turtle Mountain, July 28, 1873; 1074, Turtle Mountain, August 11, 1873; 1874, bis Turtle Mountain, August 1, 1873. . . . "Common in suitable situations all along the line. In all the specimens observed, the metamorphosis from the *Sirenodon* stage was completed at a length of four or five inches. In other regions, I have procured the same species, still in the *Sirenodon* stage but nearly twice as large. Individuals were found in damp places about the buildings at Fort Pembina and vicinity, and still more numerously around the pools at the base of Turtle Mountain. They wandered freely away from the water and in some instances entered our tents.

"In life, the coloration of the specimens examined was clear olive above, more glaucous or greenish-white below, everywhere variegated in bold pattern with black."

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6 Hankinson (1929, p. 444) reports the larvae of *Ambystoma tigrinum* as being abundant in many lakes in the state, but gives neither localities nor subspecies. Cope's records (1889, p. 85) of "Dakota" and "North Red River" are indefinite. Breckenridge (1944, p. 49, map 4) includes the whole of North Dakota in the range of *A. tigrinum s. lat.* but does not differentiate subspecific ranges.

Osborn devoted one article (1900) and a large part of another (1901) to descriptions, illustrations and discussions of specimens from Amenia and Kenmare, which Dunn later (1940, p. 160) identified as *diaboli*.

Pope (1908, p. 17) recorded *Cryptobranchus alleghenienses* from Devils Lake. Young (1912) corrected this to *Ambystoma tigrinum*. Dunn later (1940, p. 160) changed it to *A. t. diaboli*.

Dunn (1940, p. 160) gives the range of *diaboli* as "North Dakota (north and east of Altamount [Altamont] Moraine) into Alberta and Saskatchewan." Kenmare, Steele and Amenia mark the southwestern border of the range (p. 160). "Many specimens are not typical. Devils Lake, Kenmore [Kenmare] and Amenia individuals are typical. As the latter two mark the Altamount [Altamont] Moraine and I think this a convenient boundary I include in *diaboli* specimens from North Dakota which are not *slateri* [=*melanostictum*] and which are north of this moraine." (p. 161).

Telford and Stevens (1942, p. 30) give several records (see below) and report that many specimens of *A. t. diaboli* were "found infected with two apparently undescribed parasites: one, a trematode of the genus *Cercorchis;* the other, a nematode of the genus Spiroxys" (p. 31).

Bishop (1943, p. 162) gives Devils Lake, North Dakota as the type locality and the range as North Dakota (north and east of Altamont Moraine) into Alberta, Saskatchewan and Manitoba. The range is mapped on page 160. Fig. 43 (p. 164) shows photographs of an adult female taken near Lake Upsilon, North Dakota. Size, habitat, description, color, breeding and larvae are discussed (p. 162-165).

Stejneger and Barbour (1943, p. 12) mention Devils Lake as the type locality and quote the range given by Dunn (1940, p. 161).

NORTH DAKOTA RECORDS.—*Benson County:* Fort Totten Lake, collected by Crystal Thompson, August 7, 1919 (UMMZ 53786-802); Fort Totten Lake, larva collected by T. L. Hankinson, August 23, 1922 (UMMZ 65242); Mauvaise Coulee, collected by Mina Winslow, August 11, 1919 (UMMZ 53786-802); "Lake Miniwastena" (=Court Lake), 1933 (USNM 92481).

Bottineau County: Lake Metigoshe (Telford & Stevens, 1942, p. 30); Lake Metigoshe, collected by H. S. Telford, July 12, 1941 (UMNH 1450-52); Bottineau, collected by Horace Telford, September 3, 1941 (UMNH 1453).

Bottineau County or *Rolette County:* "Turtle Mountain," collected July 28 and August 11, 1873 (Coues & Yarrow, 1878, p. 291); "Turtle Mt.," collected by Dr. E. Coues (USNM 16292—this is a larva not identifiable to subspecies; I have placed it under *diaboli* because of locality); "vicinity of Turtle Mountain" (Bishop, 1943, p. 162).

Cass County: Amenia (in Rush River), larva collected by Prudence Tasker, March 21, 1899 (Osborn, 1900, p. 554); Amenia (Dunn, 1940, p. 160 & 161); Arthur, collected by Bruce K. Catlin & Charles F. Lein, August 9, 1939 (UMNH 1122); 10 miles W. of Fargo, collected by Hubbs & Schulz, June 6, 1926 (UMMZ 71508).

Cavalier County: W. of Langdon, larvae collected by Norman Gluckman, July 1940 (UMMZ 90205).

Grand Forks County: Grand Forks, larvae collected by T. L. Hankinson (UMMZ 65244); Grand Forks, collected by R. T. Young, (USNM 39273-4); Grand Forks (Bishop, 1943, p. 165—larvae).

Kidder County: Steele, collected by A. K. Fisher, July 30, 1893 (USNM 46232); Steele (Dunn, 1940, p. 160).

McHenry County: Round Lake, larvae collected by N. A. Weber, July 8, 1930 (UND).

Nelson County: Stump Lake (Young, 1924, p. 99); Tolna Lake (Telford & Stevens, 1942, p. 30).

Pembina County: Red River at Pembina, collected by "Cavileer" (USNM 4693); Pembina, collected June 24 & 28, 1873 (Coues & Yarrow, 1878, p. 291); Pembina, collected by Dr. E. Coues (USNM 11928—these four specimens have become so darkened with age that subspecific identification is difficult; I have placed them under *diaboli* because of the description by Coues & Yarrow).

Ramsey County: Devils Lake, larva collected by Mr. Brannon (UMMZ 50156—TYPE—Dunn, 1940, p. 156 & 160) (UMMZ 50157—PARATYPE); Devils Lake, collected by R. T. Young, August 21-September 1919, by A. Carpenter, August 11, 1919 and by Marion Johnson, August 7, 1919 (UMMZ 53786-802); Devils Lake, collected by E. L. Goldsborough, August 3, 1907 (USNM 38085-92); Devils Lake (Pope, 1908, p. 17) (Young, 1912) (Young 1924, p. 99) (Dunn, 1940, p. 156, 160, 161) (Bishop, 1943, p. 162, 163, 165) (Stejneger & Barbour, 1943, p. 12); Lake Irvine, collected by T. L. Hankinson, August 21, 1922 (UMMZ 65243); Sweetwater Lake, a transforming larva collected by E. L. Goldsborough, September 3, 1907 (USNM 38084); Sweetwater Lake, larvae collected by T. L. Hankinson (UMMZ 65229); Sweetwater Lake, collected by T. L. Hankinson, 1922 (USNM 118796); Sweetwater Lake (Bishop, 1943, p. 165—larvae).

Rolette County: Lake Upsilon (Telford & Stevens, 1942, p. 30); near Lake Upsilon, collected by N. A. Wood, August 1, 1920 (UMMZ 54405-9); near Lake Upsilon (Bishop, 1943, p. 163 & 164); Belcourt Lake, collected by T. L. Hankinson, August 31, 1922 (UMMZ 58872); Fish Lake, collected by T. L. Hankinson, September 1, 1922 (UMMZ 65241); 7 miles W. of St. John, collected by T. L. Hankinson, September 1, 1922 (UMMZ 65245); near St. Johns (Bishop, 1943, p. 164) (See also Bottineau County).

Ward County: Des Lacs Lake near Kenmare, collected by W. H. Makee (or G. Makee?) June 1898 (Osborn, 1900, p. 554 and 1901); Kenmare (Dunn, 1940, p. 160 & 161); Minot, collected by J. C. Salyer, September 1932 (UMMZ 74348).

3. AMBYSTOMA TIGRINUM MELANOSTICTUM (Baird)

Northwestern Tiger Salamander—Dunn (1940, p. 159) gives the range of this form (referred to as *A. t. slateri*) as "British Columbia, Alberta, Washington, Oregon, Idaho, Montana, Wyoming, North and South Dakota, Nebraska." He thinks (p. 161) that in North Dakota the Altamont Moraine is a convient boundary to separate the ranges of *diaboli* to the north and east from *melanostictum* to the south and west. He mentions (p. 160) two localities in the state, Lostwood and Lidgerwood.

Bishop (1943, p. 172) quotes Dunn's range and maps it (p. 160). Stejneger and Barbour (1943, p. 13) also quote under the name of *slateri* the range given by Dunn.

Allen (1874, p. 70) records a specimen collected at Fort A. Lincoln; he refers to it as *A. mavortium.*

NORTH DAKOTA RECORDS.—*Billings County:* Medora, larvae collected by Crystal Thompson, July 30, 1920 (UMMZ 54410-11).

Morton County: Fort A. Lincoln, collected in 1873 (Allen, 1874, p. 70).

Mountrail County: 6 miles N. of Lostwood, collected by R. Kellogg, August 18, 1915 (USNM 53131); Lostwood (Dunn, 1940, p. 160).

Richland County: Lidgerwood, collected by H. H. Sheldon, June 15, 1915 (USNM 53130); Lidgerwood (Dunn, 1940, p. 160).

Williams County: Buford, larvae collected by T. L. Hankinson, August 1922 (UMMZ 65291).

Uncertain records: Ft. Berthold, Ward Co., collected by S. M. Rothhammer (USNM 7032). There is a town called Berthold in Ward County, but old Fort Berthold was in McLean County. It doesn't matter, however, for the specimen is in many pieces and not identifiable to subspecies.

4. SCAPHIOPUS BOMBIFRONS Cope

Western Spadefoot Toad—Cope (1863), p. 53) gives "Fort Union, on the Missouri River," as one of the type localities for this species (cited also by Stejneger and Barbour, 1943, p. 37). Again in 1889 (p. 308) he records it from "Fort Union, Dak."

Stejneger and Barbour (1943, p. 37) give the range as "Kansas, Nebraska, the Dakotas, south to Oklahoma, northwestern Texas, New Mexico, and Idaho." (Referred to by Wright and Wright, 1942, p. 50).

Young (1924b, p. 59) refers to it (under the name of *S. hammondii*) as a "plains species, entering the state from the west."

In North Dakota this toad occurs in the valley of the Missouri River and the territory southwest of this river.

NORTH DAKOTA RECORDS.—*Billings County:* Medora, collected by Crystal Thompson, July 29, 1920 (UMMZ 54457-8).

McLean County: Washburn, collected by D. D. Streeter, July 28, 1909 (USNM 45516).

Williams County: Fort Union (Cope, 1863, p. 53; 1889, p. 308); Williston, collected by Crystal Thompson, July 24, 1920 (UMMZ 54456).

5. BUFO COGNATUS Say

Great Plains Toad—Young (1924, p. 56) mentions this species as occurring in the state. Wright & and Wright (1942, p. 76) give the range as: "Alberta (Logier), North Dakota and eastern Montana, southwest across Colorado, Wyoming, Kansas, Utah, Oklahoma, the Panhandle of Texas into Mexico and west into eastern California." According to Stejneger and Barbour (1943, p. 40) it is "west of the Mississippi River from Texas and Arkansas north to Minnesota and North Dakota, west to Wyoming, Utah, Nevada and the Imperial Valley, California." Breckenridge (1944, p. 59, map 7) includes the whole of North Dakota in the range.

Telford and Munro (1944) have reported on the stomach analyses of 74 great plains toads from 1 inch to 2¼ inches in length collected in or adjoining sweet clover fields in North Dakota. Volumetric computations based on the five principal food items were: sweet clover weevils 33%, ants 3%, adult beetles 29%, beetle larvae 3%, black field crickets 32%.

Telford (1944, p. 33) says that this species is "by far the most abundant"

kind of toad in North Dakota. Apparently it occurs throughout the state, but it has not been collected in the western third.

NORTH DAKOTA RECORDS.—*Cass County:* Fargo (July 29, 1943), Grandin (August 10, 1943), 5 miles W. of Mapleton (August 11, 1943), 1 mile S. of Mapleton (August 11, 1943)—Telford & Munro (1944, p. 36).

Grand Forks County: Grand Forks, collected by W. H. Wheeler, June 16, 1946 (UND).

McHenry County: Towner, collected by R. Kellogg, July 28, 1915 (USNM 53148); Towner, collected by N. A. Weber, June 21, 1930 (UND).

McLean County: Coleharbor, August 3, 1943 (Telford & Munro 1944, p. 36).

Stutsman County: Jamestown, collected by Crystal Thompson, July 24, 1921 (UMMZ 56248-9); near Jamestown, collected by Crystal Thompson (UMMZ 54428-9); 7 miles E. of Jamestown, collected by L. R. Dice, July 13, 1934 (UMMZ 76491).

Ward County: Minot, collected by J. C. Salyer, September 1932 (UMMZ 74350); Minot, collected by W. F. Stanley, May 1933 (USNM 90874-5).

Uncertain records: "Bottineau, North Dakota or Granville, North Dakota," collected by H. S. Telford, September 3, 1941 (UMNH 1456-59).

6. BUFO HEMIOPHRYS Cope

Manitoba Toad—Wright and Wright (1942, p. 82) give as the range of this species: "North Dakota, Manitoba, Alberta. In country tributary to Lake Winnipeg in Canada." Stejneger and Barbour (1943, p. 42) give it as "Alberta, Manitoba, Northwest Territory, and North Dakota." The range is mapped by Breckenridge (1944, p. 62). Dickerson (1906, p. 98) refers to the type locality—"northeastern Dakota (Turtle Mountains)" and gives the range (p. 45) as North Dakota and Manitoba. In North Dakota it ranges throughout the eastern two-thirds of the state, and, to judge from the records, must be generally abundant, although Telford (1944, p. 33) states that it is less frequently observed than *B. cognatus*.

It is of especial interest in this list to note that the type locality of *hemiophrys* is Pembina and Turtle Mountains, North Dakota (Stejneger & Barbour, 1943, p. 42). Cope (1886), in a paragraph (p. 516) following his original description (p. 515) recorded thus: "No. 11,927. Six specimens from the northern boundary of Montana. Collected by Dr. Elliott Coues." But in *The Batrachia of North America* (1889, p. 275) he changed it slightly to "No. 11927; 7 specimens; northern boundary United States, Montana; 1874; Dr. E. Coues."

Coues and Yarrow (1878, p. 288) previously reported the collection of the type specimens of *hemiophrys*, under the name of *Bufo lentiginosus fowleri* (Putnam, MSS) as follows: 1006 Pembina, June 3, 1873; 1012 Pembina, June 5, 1873; 1028 Pembina, June 7, 1873; 1031 Pembina, June 7, 1873; 1066 Turtle Mountain, July 23, 1873; 1070 Turtle Mountain, July 24, 1873; ?1086 Mouse River, August 17, 1873, ?1092 Mouse River, August 25, 1873.

Barbour and Loveridge (1929, p. 232) refer to a cotype in the Museum at Harvard as follows: "3728. One. Pembina and Turtle Mts., N. Dakota, U. S. A. E. Coues. *Exch. U. S. Nat. Mus.* 1915; *Proc. Amer. Phil. Soc.*, 1887, p. 515. An old soft specimen."

Cope also uses the date 1887 in *The Batrachia of North America* (1889, p. 273). The correct date for the original description is 1886.

At my request Dr. Doris N. Cochran has very kindly checked the records and specimens in the United States National Museum and written me as follows:

"We have the cotypes of *Bufo hemiophrys* from Pembina, North Dakota, No. 11927, collected by Dr. E. Coues. Originally there were 7 specimens, but one was sent to the Museum of Comparative Zoology on June 1, 1915, which is why it is listed in Barbour and Loveridge's catalogue of types. The 'original number' of 11927 was said to be 1012, 1020, 1028, 1031, 1066. These are parchment labels, still mostly attached, and evidently the field numbers under which Coues and Yarrow first listed them. 1066 is now re-entered as USNM 16291-2, *Bufo hemiophrys* from Turtle Mt., N. Dak. These specimens were originally catalogued as part of 10 *Rana halecina berlandieri* under USNM 11490 from 'N. W. Boundary, USA.' The other numbers on your list, 1086 and 1092 from Mouse River, do not appear to be in our files. In the 5th edition of the Check List, Stejneger & Barbour give 1886 as the date of publication for the name *hemiophrys*. As they give 'Pembina & Turtle Mts., N. Dak.' for the type locality, it is evident that USNM 16291-2 should also be considered as cotypes."

To summarize, then, *Bufo hemiophrys* was described by Cope in 1886 from seven specimens collected at Pembina, North Dakota in 1873 by Dr. E. Coues. Six of these cotypes are now in the United States National Museum (No. 11927) and one is in the Harvard Museum of Comparative Zoology (No. 3728). Apparently two additional specimens should be considered as cotypes, namely, those collected by Coues at "Turtle Mountain" (presumably the Turtle Mountains in North Dakota); they are in the United States National Museum (No. 16291-2).

NORTH DAKOTA RECORDS.—*Benson County:* Fort Totten Lake, collected by Crystal Thompson, August 7, 1919 (UMMZ 53754) and June 21, 1921 (UMMZ 56245); Court Lake, collected by Crystal Thompson, July 31, 1919 (UMMZ 53739 & 53747); Mauvaise Coulee, collected by Crystal Thompson, July 11, 1919 (UMMZ 53744).

Bottineau County: Lake Metigoshe, collected by Crystal Thompson, July 16, 1919 (UMMZ 53737).

Bottineau County or *Rolette County:* "Turtle Mountain," COTYPES collected by E. Coues, 1873 (USNM 16290-1) (Coues & Yarrow, 1878, p. 288); Bluebill Lake, collected by Crystal Thompson, August 6, 1920 (UMMZ 54435-6 & 54455); Turtle Mountains, collected by N. A. Wood, August 1, 1920 (UMMZ 54454).

Cass County: Red River above Fargo, collected by Hubbs and Schultz, June 5, 1926 (UMMZ 65050).

Grand Forks County: Grand Forks, collected by G. C. Wheeler, May & July 1927 (UND); Larimore, collected by R. Kellogg, 1915 (USNM 53160-4, 52457-9); Manvel, collected by R. Kellogg, June 21, 1915 (USNM 53143).

Kidder County: 4 miles S. of Dawson, collected by Biological Survey, July 31, 1915 (USNM 53158).

McHenry County: Round Lake, collected by N. A. Weber, June 24, 1930 (UND); Towner, collected by R. Kellogg, July 28, 1915 (USNM 53146-7).

Nelson County: Sheyenne River near Tolna, collected by Crystal Thompson, July 25,

1919 (UMMZ 53746); Stump Lake, collected by Crystal Thompson, July 18, 1919 (UMMZ 54452) and July 24, 1919 (UMMZ 53748).

Pembina County: Pembina, COTYPES collected by E. Coues, June & July 1873 (USNM 11927) (Coues & Yarrow, 1878, p. 288); Walhalla, collected by Norman Gluckman, summer of 1940 (UMMZ 90204); Walhalla (Wright & Wright, 1942, p. 83).

Ramsey County: Devils Lake, collected by Crystal Thompson, July 21, 1919 (UMMZ 53755), July 9, 1919 (UMMZ 53743), July 30, 1919 (UMMZ 53753) and August 3 & 8, 1919 (UMMZ 53756-7); Lac aux Mortes, collected by Crystal Thompson, July 6, 1919 (UMMZ 53758) and July 18, 1920 (UMMZ 54430); Garske, collected by Crystal Thompson, July 18, 1920 (UMMZ 54431-4); Odessa Narrows, collected by Crystal Thompson, July 23, 1919 (UMMZ 53745).

Richland County: Wahpeton, collected by V. Bailey, June 1915 (USNM 53153-6).

Rolette County: Gravel Lake, collected by Crystal Thompson, July 16 & 17, 1919 (UMMZ 53749-50); Fish Lake collected by H. V. Williams, June 21, 1912 (USNM 49588); Fish Lake, collected by T. L. Hankinson, September 1, 1922 (UMMZ 65240); Lake Upsilon, collected by Crystal Thompson, July 16-19, 1919 (UMMZ 53738, 53740-2 & 53751-2) (See also Bottineau County).

Walsh County: Ardoch (Wright & Wright, 1942, p. 83).

Ward County: Minot, collected by H. S. Telford, September 3, 1941 (UMNH 1454-55); Minot, collected by W. T. Stanley, May 30, 1933 (UMMZ 74352).

Uncertain records: "N. Dak?" collected by H. H. Sheldon (USNM 53159); "Mouse River" (Coues & Yarrow, 1878, p. 288).

7. BUFO WOODHOUSII WOODHOUSII Girard

Woodhouse's Toad—This western from ranges across the state, but has not been reported from the counties bordering Canada.

NORTH DAKOTA RECORDS.—*Billings County:* Medora, collected by Crystal Thompson, July 29 through August 15, 1920 (UMMZ 54443-4, 54446, 54448, 56918-21). Hanley Road 11 miles S. of Medora, collected by Crystal Thompson, July 31, 1920 (UMMZ 54426-7).

Cass County: 10 miles W. of Fargo, collected by Hubbs & Schultz, June 6, 1926 (UMMZ 71487); Maple River N. of Mapleton, collected by Hubbs & Schultz, June 6, 1926 (UMMZ 71488).

Grand Forks County: Grand Forks, July 1927 (UND).

Hettinger County: Mott, collected by Hubbs & Schultz, June 9, 1926 (UMMZ 65048).

McKenzie County: Goodall, collected by R. Kellogg, September 2, 1915 (USNM 53150).

Mercer County: Stanton, collected by R. Kellogg, October 6, 1915 (USNM 53144-5).

Slope County: Little Missouri River at Marmarth, collected by Hubbs & Schultz (UMMZ 65049).

Ward County: Minot, collected by W. F. Stanley, May 1933 (USNM 90876).

Williams County: Buford, collected by Crystal Thompson, July 23, 1920 (UMMZ 54438-42); Williston, collected by Crystal Thompson, July 24, 1920 (UMMZ 54447, 54453).

Doubtful record: Bufo columbiensis (Allen, 1874, p. 70) probably *woodhousii*, "occasional but far from common"—no definite localities.

8. PSEUDACRIS NIGRITA SEPTENTRIONALIS (Boulenger)

Swamp Tree Frog—Cope (1889, p. 343) records this frog (under the name of *Chorophilus triseriatus*) from "Fort Union, Dak."

Wright and Wright (1942, pp. 114-115) describe specimens from Pembina.

Breckenridge (1944, p. 66, map 10) includes all of North Dakota in the range of *Ps. nigrita* but does not differentiate subspecific ranges.

This northwestern form has been reported mostly from the northern half of the state.

NORTH DAKOTA RECORDS.—*Billings County:* Peaceful Valley Ranch, collected by Crystal Thompson, August 11, 1922 (UMMZ 56916).

Bottineau County: Mouse River 8 miles NW of Kramer, collected by C. J. Henry, May 18, 1936 (UMMZ 80536); Oak Creek in Turtle Mts., collected by N. A. Wood, July 4, 1921 (UMMZ 56246).

Bottineau or *Rolette County:* Turtle Mts., collected by Crystal Thompson, July 22, 1919 (UMMZ 53783); Bluebill Lake, August 6, 1920 (UMNH 70-72).

Griggs County: Red Willow Lake, collected by T. L. Hankinson, August 26, 1922 (UMMZ 65230).

McHenry County: 8 miles N. of Towner, collected by R. Kellogg, August 6, 1915 (USNM 53124); Towner, collected by N. A. Weber, September 17, 1928 (UND).

Nelson County: Stump Lake, collected by N. A. Wood, July 24, 1929 (UMMZ 54450); Stump Lake, August 15, 1912 (UND); Stump Lake, collected by Crystal Thompson, July 24, 1919 (UMMZ 53780).

Pembina County: Pembina, August 30 & 31, 1930 (Wright & Wright, 1942, p. 114 & 115).

Ramsey County: Lac aux Mortes, collected by Crystal Thompson, July 6 & 21 and August 8, 1919 (UMMZ 53778-9, 53781); Devils Lake, collected by Mina Winslow, July 12, 1919, and by R. T. Young, August 8, 1919 (UMMZ 53784-5); Devils Lake, collected by Crystal Thompson, July 20, 1920 (UMMZ 54445); Devils Lake, collected by N. A. Wood, July 25, 1922 (UMMZ 65232); Garske, collected by Crystal Thompson, July 18, 1920 (UMMZ 54451).

Rolette County: Bluebill Lake, collected by Crystal Thompson, August 6, 1920 (UMMZ 54437); Lake Upsilon, collected by T. H. Hubbell, August 4, 1920 (UMMZ 54459); Fish Lake, collected by T. L. Hankinson, September 1, 1922 (UMMZ 65231); St. John, collected by T. L. Hankinson, September 1, 1922 (UMMZ 65247) (See also Bottineau County).

Ward County: Minot, collected by W. F. Stanley, 1933 (USNM 92550-8).

Williams County: Williston, collected by Crystal Thompson, July 24, 1920 (UMMZ 54449); Fort Union, collected by Dr. J. Suckley and by Dr. F. V. Hayden (Cope, 1889, p. 343).

Uncertain records: "Red River of the North (R. Kennicott)" and "Upper Missouri," collected by Dr. F. V. Hayden (Cope, 1889, p. 343); Lake O near Devils Lake, collected by E. Mohberg, July 22, 1919 (UMMZ 53782); "betw. Pike Lake & Ft. Union," collected by Lt. Gross (USNM 3309).

9. RANA CATESBEIANA Shaw

Bullfrog—Stejneger and Barbour (1943, p. 56) gives as the range of the bullfrog: "North America east of the Rocky Mountains except extreme southeast and Gulf States coastal plain. (Introduced into many localities all over

North America and Cuba)." Breckenridge does not, however, map North Dakota in the range (1944, p. 75, map 13). In fact, he has only one record for Minnesota and that is from the extreme southeastern corner. It is, therefore, surprising to find a specimen collected in North Dakota approximately 400 miles northwest of the previously reported range.

NORTH DAKOTA RECORD.—*Griggs County:* Lake Sibley, collected by W. S. Wood (USNM 3331).

10. RANA PIPIENS Schreber

Leopard Frog—The earliest records[7] of this species are from 1873. Allen's notes were based on the Northern Pacific Railroad Expedition of that year, which traveled from Fort Rice (now in Morton County, North Dakota) on the Missouri River westward to the Yellowstone River in Montana. No definite localities are mentioned. Referring to it as *Rana halecina,* he reports it (p. 70) as "rather frequent along streams and quite generally dispersed." On the same page: "By far the most common species [of batrachian], but is yet comparatively scarce." (Allen, 1874).

Other 1873 records are to be found in a paper by Coues and Yarrow (1878, p. 289), also under *Rana halecina,* as follows: 1064, bis. ter. etc., Near Pembina Mountains, July 9, 1873, numerous specimens; ?1081, Souris River, August 16, 1873; ?1081, bis, Souris River, August 16, 1873.

Ballou was obviously referring to *Rana pipiens* in his brief note of 1887: "The frogs hibernate in the river bottom during winter, but every spring the entire army migrates to the sloughs, returning *en masse* in the fall. . . . Last autumn, in Fargo, I saw the frogs hopping towards the river in large numbers and the citizens gather them for a two-weeks' feast."

In 1907 "leopard frogs were everywhere abundant along the shores" of Devils Lake (Pope, 1908, p. 17). Young (1924, p. 99) reported that *Rana pipiens* occurred in Devils Lake and Stump Lake, both of which are brackish. He stated that it did not breed in Devils Lake.

Hankinson (1929, p. 444) said that "frogs (principally *Rana pipiens*) were common shore-dwellers" in the state but mentioned no localities.

Telford and Stevens (1942, p. 31): "The leopard frog, *Rana pipiens,* was the most abundant frog encountered, being particularly abundant at Tolna."

Wright and Wright (1942, p. 208-209)refer to a trip "from Spicer, Minn., northward to Rainy Lake, westward to Walhalla, N. D., and then southward and eastward over a different route to St. Paul, Minn.," during which many "meadow frogs" were seen, but no definite localities are given.

Breckenridge includes the whole of North Dakota in the range of this frog (1944, p. 82, map 16). This is supported by the following records.

NORTH DAKOTA RECORDS.—*Barnes County:* Valley City, collect-d by E. G. Holt, August 6, 1917 (USNM 66613-5).

Benson County: Tokio, collected by Crystal Thompson, July 31, 1919 (UMMZ 53759 & 53763); Tokio, collected by R. Kellogg, July 4, 1915 (USNM 53095); Sully's Hill, collected by Crystal Thompson, August 7, 1919 (UMMZ 53760)

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7 There is an earlier though indefinite record: Captain Meriwether Lewis wrote on April 15, 1805, in what is now Mountrail County, "I heard frogs crying for the first time this season." (Thwaites, 1904, p. 312).

and July 19, 1920 (UMMZ 54423); Court Lake, collected by Crystal Thompson, July 31, 1919 (UMMZ 53761); Spring Lake, collected by R. Kellogg, July 6, 1915 (USNM 53086); Ft. Totten, collected by R. Kellogg, July 16, 1915 (USNM 53099).

Benson County or *Eddy County:* Wood Lake, collected by R. Kellogg, July 5, 1915 (USNM 53087-8).

Bottineau County: Bottineau, collected by Crystal Thompson, July 2, 1919 (UMMZ 53808).

Bowman County or *Slope County:* Cedar Creek (tributary to Cannonball River), collected by Hubbs & Schultz, June 9, 1926 (UMMZ 65051).

Cass County: Fargo, autumn of 1886 (Ballou, 1887, p. 388).

Cavalier County: Near Pembina Mountains, collected by E. Coues, July 9, 1873 (Coues & Yarrow, 1878, p. 289).

Eddy County: "Monahan's Ranch on Sheyenne River near Warwick," collected by Crystal Thompson (August 4, 1920) and Robert Johnstone (August 8, 1920) (UMMZ 54417 & 54425); Sheyenne River near Warwick, collected by Crystal Thompson, July 26, 1919 (UMMZ 53762) (See also Benson County).

Grand Forks County: Grand Forks, collected by G. C. Wheeler, September 29, 1945 (UND); State Park near Arvilla, collected by G. C. Wheeler, September 30, 1945 and April 28, 1946 (UND); Larimore, collected by R. Kellogg, June 24, 1915 (USNM 52454-5).

Griggs County: Red Willow Lake, collected by T. L. Hankinson, August 26, 1922 (UMMZ 65237).

Hettinger County: Cannon Ball River at Mott, collected by Hubbs and Schultz, June 9, 1926 (UMMZ 65052).

McHenry County: Round Lake, collected by N. A. Weber (UND); Mouse River, 6 miles N. of Towner, collected by N. A. Weber (UND).

McKenzie County: Mouth of Yellowstone River, collected by Dr. F. V. Hayden (USNM 9459); Goodall, collected by R. Kellogg, September 1915 (USNM 53091-4).

McLean County: Washburn, collected by D. D. Streeter, July 26, 1909 (USNM 45505-6).

Morton County: Curlew River W. of Sims, collected by Hubbs & Schultz, June 8, 1926 (UMMZ 71489); tributary to Sweet Briar Creek between Mandan and New Salem, collected by Hubbs and Schultz, June 8, 1926 (UMMZ 71491).

Mountrail County: Lostwood, collected by R. Kellogg, August 14, 1915 (USNM 53089).

Nelson County: Stump Lake, collected by Crystal Thompson, July 24, 1919 (UMMZ 53765); Stump Lake, collected by N. A. Wood, July 24, 1920 (UMMZ 54416); Stump Lake (Young, 1924, p. 99); Tolna, 1941 (Telford and Stevens, 1942, p. 31).

Pembina County: Red River at Pembina, collected by Crystal Thompson, July 9, 1921 (UMMZ 56247); Pembina, collected by T. L. Hankinson, September 29, 1922 (UMMZ 65238).

Ramsey County: Devils Lake (Pope, 1908, p. 17); Devils Lake, collected by E. L. Goldsborough, July 23, 1907 (USNM 38093); Devils Lake (Young, 1924, p. 99); Odessa Narrows, collected by Crystal Thompson, July 23, 1919 (UMMZ 53764 & 53766).

Richland County: Wahpeton, collected by V. Bailey, June 3 (USNM 53090) and June 4 (USNM 53133) 1915.

Rolette County: Jarves Lake S. of Birchwood, collected by T. L. Hankinson, September 3, 1922 (UMMZ 65235); Gravel Lake, collected by Crystal Thompson, July 19, 1919 (UMMZ 53767); Dunseith, collected by Crystal Thompson, July 16, 1919 (UMMZ 53768); Fish Lake, collected by T. L. Hankinson, September

1, 1922 (UMMZ 65239); 7 miles W. of St. John, collected by T. L. Hankinson, September 1, 1922 (UMMZ 65246).

Slope County: Little Missouri River at Marmarth, collected by Hubbs & Schultz, June 9, 1926 (UMMZ 65054) (See also Bowman County).

Stark County: Heart River 10 miles S. of Richardton, collected by Hubbs & Schultz, June 8, 1926 (UMMZ 71490).

Stutsman County: Jamestown, collected by Crystal Thompson, August 4, 1920 (UMMZ 54424); James River at Jamestown, collected by T. L. Hankinson, September 15, 1922 (UMMZ 65236).

Ward County: Minot, collected by J. C. Salyer, September 1932 (UMMZ 74349); Kenmare, collected by V. Bailey, July 15, 1913 (USNM 50001).

Williams County: Missouri River at Buford, collected by Crystal Thompson, July 23, 1920 (UMMZ 54418-21); Williston, collected by Crystal Thompson July 24, 1920 (UMMZ 54422); Fort Union, collected by E. J. Denig (USNM 3320); 4 miles W. Grinnell, collected by R. Kellogg, August 28, 1915 (USNM 53096).

Uncertain records: "N.W. Boundary," collected by Dr. E. Coues (USNM 11490); "Souris River," collected August 16, 1873 (Coues & Yarrow, 1878, p. 289); "Devils Lake, Grand Forks," collected by R. T. Young (USNM 39275-6).

11. RANA SYLVATICA CANTABRIGENSIS Baird

Wood Frog—"There is some uncertainty regarding the distinction between *R. s. cantabrigensis* and *R. s. sylvatica*. . . . The distinction between the two subspecies . . . concerns the relative length of leg. In Minnesota those to the southeast have longer legs than those to the northwest. The gradation is gradual, and authorities differ as to whether the separation should be made or whether a separation should be recognized at all. . . . Patch has suggested . . . distinguishing them on the basis of whether the leg, minus the foot, is longer or shorter than the body. On this basis all Minnesota material would be referred to *R. s. cantabrigensis* [that is, with legs shorter than the body]." (Breckenridge, 1944, p. 89-91).

Wright and Wright (1942, p. 220 & 221) refer to collecting this frog at Pembina. Breckenridge (1944, p. 90, map 18) includes only Pembina in the range.

This northwestern frog apparently occurs only in the northeastern part of the state.

NORTH DAKOTA RECORDS.—*Benson County:* Court Lake, collected by Crystal Thompson, July 31, 1919 (UMMZ 53773); Ft. Totten, collected by R. Kellogg, July 14, 1915 (USNM 53103-4).

Bottineau County or *Rolette County:* Bluebill Lake, collected by Crystal Thompson, August 6, 1920 (UMMZ 54412).

Eddy County: Sheyenne River (near Warwick), collected by Crystal Thompson, July 26, 1919 (UMMZ 53769).

Grand Forks County: Larimore, collected by R. Kellogg, June 26, 1915 (USNM 52452-3); Manvel, collected by R. Kellogg, June 21, 1915 (USNM 53113-23); University (Grand Forks), collected by R. T. Young (USNM 39277); State Park near Arvilla, collected by G. C. Wheeler, April 28, 1946 (UND).

McHenry County: 8 miles N. of Towner, collected by R. Kellogg, July-August 1915 (USNM 53105-12); Mouse River 14 miles N. of Towner, collected by N. A. Weber, July 22, 1930 (UND).

Nelson County: Stump Lake, collected by Crystal Thompson, July 24, 1919 (UMMZ

53777); Stump Lake, collected by N. A. Wood, July 24, 1920 (UMMZ 54413-5).

Pembina County: Pembina (Wright & Wright, 1942, p. 220 & 221).

Ramsey County: Lac aux Mortes, collected by Crystal Thompson, July 6, 1919 (UMMZ 53770).

Rolette County: Carpenter Lake, collected by T. L. Hankinson, September 2, 1922 (UMMZ 65233); Lake Upsilon, collected by Crystal Thompson, July 10, 17 & 19, 1919 (UMMZ 53771-2 & 53775-6); Gravel Lake, collected by Crystal Thompson, July 17, 1919 (UMMZ 53774); Turtle Mts. near St. John, collected by R. T. Young (USNM 52398); 6 miles W. of St. John, collected by C. W. Hargrave (UND). (See also Bottineau County.)

Uncertain records: "N. Dak.," collected by R. Kellogg, 1915 (USNM 53102); Lake Erwin, collected by T. L. Hankinson, August 21, 1922 (UMMZ 65234).

Annotated List of the Reptiles of North Dakota[8]

1. PHRYNOSOMA BREVIROSTRE (Girard)

Horned Lizard, Horned "Toad"—Allen (1874, p. 69) found this species in the state in 1873. Under the name of *Ph. douglassi* he reported it as "occasional throughout the region traversed, but very common only at a few localities."

Young (1924b, p. 59) says that this "characteristic plains species" is rare in the state.

Stejneger and Barbour (1943, p. 92) give the range as "North Dakota, Wyoming, the basins of the Yellowstone and Platte Rivers." It has been collected only in the southwestern part of the state.

Smith (1946) considers *brevirostre* to be a subspecies of *douglassii*. He includes only the extreme southwestern corner of North Dakota in the range (p. 498, map 21).

NORTH DAKOTA RECORDS.—*Billings County:* Peaceful Valley Ranch, collected by Crystal Thompson, August 15, 1922 (UMMZ 56917); near Medora (UMMZ 58654); Mikkelson, collected by J. E. Goldsberry, September 10, 1935 (UND).

Golden Valley County: Beach, collected by H. S. Telford, September 11, 1941 (UMNH 1157).

McKenzie County: "40 miles N. of Sentinel Butte," collected by J. E. Goldsberry, September 10, 1935 (UND).

2. EUMECES SEPTENTRIONALIS SEPTENTRIONALIS (Baird)

Black-banded Skink—Taylor (1935, p. 404) gives the range as "Canada, North Dakota, South Dakota, Minnesota, Wisconsin, Iowa, Nebraska, Kansas, and Oklahoma." He cites (p. 405) the two records given below and maps them (p. 403, fig. 67).

Smith (1946, p. 530) refers to Taylor's records and maps (p. 505) the eastern two-thirds of North Dakota in the range of this skink.

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8 I have not included in this list *Lampropeltis triangulum triangulum* (Lacépède), collected by Wesley Dayton, summer 1932, near Granville in McHenry County (UMMZ 74338). This is about 400 miles northwest of the recorded range in southeastern Minnesota. Some error is to be suspected unless further collecting substantiates its occurrence in North Dakota.

Breckenridge (1944, p. 99) refers to the range given by Taylor and includes the eastern half of North Dakota in the range (p. 98, may 21). It has been collected only in the extreme southeastern corner of the state.

NORTH DAKOTA RECORDS.—*Richland County:* Lidgerwood, collected by H. H. Sheldon, June 15, 1915 (USNM 53044); Wahpeton, collected by V. Bailey, June 4, 1915 (USNM 53045).

3. HETERODON CONTORIX CONTORIX (Linnaeus)

Eastern Hog-nosed Snake, Puffing Adder, Spreading Adder—Breckenridge includes southwestern North Dakota in the range of this snake (1944, p. 106, map 23).

Conant (1938, p. 42, map 8) includes the southern half of the state.

NORTH DAKOTA RECORDS.—*McKenzie County:* Upper Missouri and Yellowstone Rivers, collected by Dr. F. V. Hayden (USNM 1273).

4. HETERODON NASICUS NASICUS (Baird & Girard)

Western Hog-nosed Snake—Allen (1874, p. 69) recorded a specimen "taken near the head of the Heart River, and another in the Valley of the Yellowstone."

Young (1924b, p. 56) mentions the occurrence of this snake in the state and also refers (p. 59) to it as a "plains species, entering the state from the west."

Breckenridge (1944, p. 110, map 24) includes the whole of North Dakota in the range. The records support this.

NORTH DAKOTA RECORDS.—*Barnes County:* Nome, collected by Dr. S. A. Nesse, July 12, 1938 (UMNH 836).

Billings County: Medora, collected by "young men of city," August 1, 1920 (UMMZ 54462); Peaceful Valley Ranch, collected by Crystal Thompson, August 8 & 13, 1922 (UMMZ 56910-11); 11 miles S. of Medora, collected by Crystal Thompson, July 31, 1920 (UMMZ 54463).

Billings County or *Stark County:* "near the head of the Heart River," (Allen, 1874, p. 69).

Bottineau County: Lake Metigoshe, collected by J. C. Salyer, May 25, 1933 (UMMZ 74345).

McHenry County: Granville, collected by Wesley Dayton, summer 1932 (UMMZ 74346); 6 miles S. of Towner, collected by N. A. Weber, June 9, 1928 (UND).

Morton County: 6 miles S.E. of Almont, collected by C. W. Hargrave, May 2, 1946.

Ransom County: (no locality) collected by Roy Nagel, September 21, 1939 (UMNH 1016).

Richland County: Hankinson, collected by V. Bailey, July 21, 1912 (USNM 49602).

Stark County: See Billings County.

Ward County: Minot, collected by J. C. Salyer, May 13, 1933 (UMMZ 74343).

5. OPHEODRYS VERNALIS BLANCHARDI Grobman

Western Smooth Green Snake—Grobman (1941, p. 17 and map on p. 38) gives four "accepted records" for this subspecies, but "only one record is listed for each county." (See under "records" below).

Schmidt and Davis (1941, p. 120) give as the range of this subspecies: "Western Ohio and Indiana, through Illinois, Iowa, and northern Missouri

to eastern Kansas and Nebraska and the Dakotas; a considerable area in northeastern Utah, in Colorado and in the Mountains of New Mexico." Grobman's map is reproduced on page 76.

Breckenridge maps all but the extreme western part of North Dakota in the range of *O. vernalis s. lat.* but does not differentiate subspecific ranges (1944, p. 113, map 25). The few known records for the state are in accord

NORTH DAKOTA RECORDS.—*Benson County:* Sully's Hill, collected by Crystal Thompson, August 7, 1919 (UMMZ 54460) (referred to by Grobman, 1941, p. 17, as in Ramsey County); "road to Ft. Totten," collected by Crystal Thompson, July 19, 1920 (UMMZ 54461) (referred to by Grobman, 1941, p. 17).

Burke County: Columbus, October 1930 (UND).

Foster County: Mc Henry (UND).

Sioux County: Cannon Ball, collected by H. H. Sheldon, August 19, 1915 (USNM 53079) (referred to by Grobman, 1941, p. 17, as in Morton County).

Ward County: Minot, collected by J. C. Salyer, May 25, 1933 (UMMZ 74344) (referred to by Grobman, 1941, p. 17).

6. COLUBER CONSTRICTOR FLAVIVENTRIS (Say)

Blue Racer—Breckenridge includes the southwestern part of North Dakota in the range of *C. constrictor s. lat.* but does not differentiate subspecific ranges (1944, p. 116, map 26).

Ortenburger's map (1928) shows two spots in North Dakota, one near Williston and one near Grinnell. He says that the most northern record for the subspecies is that near Grinnell (p. 183).

Conant (1938, p. 50, map 11) includes the southwestern corner of North Dakota in the range of this subspecies.

The following records show the range in North Dakota to be the valley of the Missouri River and the territory southwest of that stream.

NORTH DAKOTA RECORDS.—*Adams County:* East of Cook, August 29, 1932 (UMNH 406).

Billings County: Petrified Forest, collected by Mr. Olson (UMMZ 56905); Mikkelson, collected by J. E. Goldsberry, July 1929 (UND).

Grant County: Heart River in N.E. corner of county, collected by C. W. Hargrave, May 12, 1946 (UND).

Sioux County: Cannonball, collected by H. H. Sheldon, August 27, 1915 (USNM 53074).

Williams County: Whitehouse Ranch near Williston, collected by V. Bailey, July 27, 1913 (USNM 50000); four miles W. of Grinnell, collected by R. Kellogg, August 26, 1915 (USNM 53031). (Both referred to by Ortenburger, 1928).

Uncertain records: "N. Dak.," August 24, 1930 (UMNH 182).

7. PITUOPHIS SAYI SAYI (Schlegel)

Bull Snake—Stull (1940, p. 106) has this to say concerning the distribution of the bull snake in North Dakota: "Billings County, 4 miles north of Medora; Morton County, Cannon Ball. The indefinite locality 'Upper Missouri and Upper Yellowstone Rivers' and the locality 'Goodall,' which cannot be located, are also given." Her map (p. 36) shows the range as south and west of the Missouri River. This same distribution is mapped by Schmidt and Davis (1941, p. 161). The following records confirm this range.

NORTH DAKOTA RECORDS.—*Billings County:* Peaceful Valley Ranch, collected by Crystal Thompson, August 8, 1922 (UMMZ 56912) (presumably referred to by Stull, 1940, p. 106).

McKenzie County: Goodall, collected by R. Kellogg, September 14, 1915 (USNM 53027); Upper Missouri and Yellowstone Rivers, collected by Dr. Hayden (USNM 1553). Both these records referred to by Stull (1940, p. 106).

Sioux County: Cannon Ball, collected by H. H. Sheldon, August 22, 1915 (USNM 53081) (referred to by Stull, 1940, p. 106).

Slope County: H. T. Ranch near Amidon, collected by G. G. Wheeler, June 15, 1928 (UND).

8. STORERIA OCCIPITOMACULATA OCCIPITOMACULATA (Storer)

Red-bellied Snake—Conant (1938, p. 93) gives the range of this snake as "central Maine to southern Manitoba, south to north central Florida, and west to the Great Plains in Kansas and the Dakotas." On map 21 he includes all but the northwestern corner of North Dakota in the range.

Stejneger and Barbour (1943, p. 164) give as the range: "From Ontario and Lake Superior southward to central Florida and Vera Cruz, westward to Kansas, Iowa, and North Dakota." This is quoted by Breckenridge (1944, p. 140), who includes the eastern edge of the state in the range (map 33, p. 139).

Trapido (1944, p. 20) maps approximately the eastern half of the state in the range of this snake and cites (p. 32) two records.

The three records given below are all in the north central part of the state.

NORTH DAKOTA RECORDS.—*Benson County:* Harlow (UND).

Bottineau County or *Rolette County:* Turtle Mountains, collected by A. Eastgate (UMMZ 54473) (mentioned by Trapido, 1944, p. 32).

McHenry County: no locality (Trapido, 1944, p. 32).

9. THAMNOPHIS RADIX (Baird & Girard)

Plains Garter Snake—"Throughout the Red River region, from Pembina to where the Coteau de Missouri crosses the line, it is the characteristic ophidian, the principal and almost the only representative of its order, outnumbering all the others put together. . . . In the more fertile portions of the Red River Valley itself, this snake may be found almost anywhere in the brush and herbage. Out on the drier prairie beyond, it is chiefly confined to the pools and streams. . . . The greater part of the females observed in July and August will be found pregnant, the young numbering sometimes as many as thirty or forty. Individuals were taken *in coitu* in September and part of October." (Coues and Yarrow, 1878, p. 278). These authors also give several records (p. 279-280) for this snake under the names of *Eutaenia radix* and *E. r. twiningi* (see below).

This is the commonest snake throughout most parts of the state. Its range includes the entire state (Breckenridge, 1944, p. 142, map 34; Schmidt & Davis, 1941, map p. 243).

NORTH DAKOTA RECORDS.[9]—*Adams County:* Hettinger, collected by Hubbs & Schultz, June 9, 1922 (UMMZ 65061).

Barnes County: Valley City, collected by E. G. Holt, August 6, 1917 (USNM 66616).

Benson County: Spring Lake, collected by R. Kellogg, July 3, 1915 (USNM 53072) (See also Eddy County).

Billings County: Medora, collected by Crystal Thompson, July 30, 1920 (UMMZ 54465); Peaceful Valley Ranch, collected by Crystal Thompson, August 8 and 10, 1922 (UMMZ 56906-08); Little Missouri River near Medora, collected by Crystal Thompson, August 8, 1922 (UMMZ 56909).

Bottineau County: near Bottineau, collected by Crystal Thompson, July 19, 1919 (UMMZ 53803-05).

Bottineau County or *Rolette County:* "Turtle Mt.," collected by E. Coues, July 22, 1873 (USNM 9539); "Turtle Mountain," July 22 & 23, 1873 (Coues & Yarrow, 1878, p. 277).

Cavalier County: W. of Langdon, collected by Norman Gluckman, July 1940 (UMMZ 90202).

Eddy County: Monahan's Ranch on Sheyenne River (near Warwick), collected by Crystal Thompson, August 8, 1920 (UMMZ 54469).

Eddy County or *Benson County:* Wood Lake, collected by R. Kellogg, July 5, 1915 (USNM 53037).

Grand Forks County: Grand Forks, July 1927 (UND); Larimore, collected by R. Kellogg (USNM 52450).

McHenry County: 8 miles N. of Towner, collected by R. Kellogg, July 28, 1915 (USNM 53036).

McKenzie County: Goodall, collected by R. Kellogg, September 14, 1915 (USNM 53038); Missouri & Yellowstone Rivers, collected by Dr. Hayden (USNM 695, 700 & 710).

Mountrail County: Lostwood, collected by R. Kellogg, August 14, 1915 (USNM 53073).

Nelson County: Stump Lake, collected by T. H. Hubbell, July 24, 1920 (UMMZ 54467-68 & 54471-72).

Pembina County: Pembina, collected by E. Coues, June 5, 1873 (USNM 9530), June 7, 1873 (USNM 9528 & 9536) & June 24, 1873 (USNM 9529); "Pembina?" collected by E. Coues, June 1873 (USNM 9535); Pembina, June 5, 7 & 24, 1873 (Coues & Yarrow, 1878, p. 277).

Ramsey County: Devils Lake, collected by E. L. Goldsborough, August 1, 1907 (USNM 38082-3); Devils Lake, collected by Crystal Thompson, July 20, 1920 (UMMZ (54466).

Richland County: Wahpeton, collected by V. Bailey, June 4, 1915 (USNM 53030); Hankinson, collected by V. Bailey, July 25,1912 (USNM 49601).

Rollette County: Lake Upsilon, collected by N. A. Wood, August 1, 1920 (UMMZ 54470); Fish Lake, collected by H. V. Williams, June 21, 1912 (USNM 49589) (See also Bottineau County).

Ward County: Kenmare, collected by V. Bailey, July 15, 1913 (USNM 50002).

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9 Hankinson (1929, p. 443) states that "a few garter snakes (*Thamnophis*) were seen on lake and stream shores." Telford and Stevens (1942, p. 32) report that "a garter snake, *Thamnophis* sp., was frequently encountered" in their survey of 19 lakes and ponds scattered throughout the state. In neither case are definite records or identifications given.

Williams County: Buford, collected by T. L. Hankinson, August 26, 1922 (UMMZ 65289-90); 4 miles W. of Grinnell, collected by R. Kellogg, August 27-28, 1915 (USNM 53033-34).

Uncertain records: Mouse River, collected by E. Coues, August 25, 1873 (USNM 9533) and August 20, 1873 (USNM 9538); Mouse River (Coues & Yarrow, 1878, p. 279-280); "N.Dak.?" collected by R. Kellogg (USNM 53035).

10. THAMNOPHIS SAURITUS PROXIMUS (Say)

Western Ribbon Snake—Allen (1874, p. 69) refers to this snake under the name of *Eutaenia proxima*: "Not common. Less than half a dozen representatives of the genus Eutaenia seen on the whole trip."

This south-central form has been collected only in the western half of the state.

NORTH DAKOTA RECORDS.—*McHenry County:* 8 miles S. of Granville, collected by Wesley Dayton, summer of 1932 (UMMZ 74337).

Ward County: Minot, collected by J. C. Salyer, September 16 & 21 and October 1, 1932 (UMMZ 74339-42).

11. THAMNOPIS SIRTALIS PARIETALIS (Say)

Red-sided Garter Snake—Breckenridge includes the whole of North Dakota in the range (1944, p. 146, map 35) of *T. sirtalis*, but does not differentiate subspecific ranges. *T. s. sirtalis* which had been recorded from western Minnesota, may occur in the extreme eastern part of North Dakota, but I have found no records. *T. s. parietalis* should be found throughout the state but records are from the western half only.

NORTH DAKOTA RECORDS.—*Burleigh County:* Bismarck, collected by D. D. Streeter, July 16, 1909 (USNM 44345).

McKenzie County: Yellowstone & Missouri Rivers, collected by Dr. Hayden (USNM 872).

Williams County: Williston, collected by Crystal Thompson, July 24, 1920 (UMMZ 54464).

12. CROTALUS VIRIDIS VIRIDIS Rafinesque

Prairie Rattlesnake—The earliest report of the rattlesnake in North Dakota is probably that of Captain Meriwether Lewis in the journal of the Lewis and Clark Expedition (Thwaites, 1904, p. 257-258). It is dated February 11, 1805 and was written at Fort Mandan, which was situated in what is now McLean County on the east bank of the Missouri River about eight miles below the mouth of the Knife River. Here is the account:

"About five Oclock this evening one of the wives [Sacajawea] of Charbono was delivered of a fine boy. it is worthy of remark that this was the first child which this woman had boarn, and as is common in such cases her labour was tedious and the pain violent; Mr. Jessome informed me that he had freequently administered a small portion of the rattle of the rattle-snake, which he assured me had never failed to produce the desired effect, that of hastening the birth of the child; having the rattle of a snake by me I gave it to him and he administered two rings of it to the woman broken in small pieces with the fingers and added to a small quantity of water. Whether this medicine was truly the cause or not I shall not undertake to determine, but I

was informed that she had not taken it more than ten minutes before she brought forth; perhaps this remedy may be worthy of future experiments, but I must confess that I want faith as to it's efficacy."

The next record is doubtless that of Bradbury (1819, p. 147), for June 21, 1811. His party was traveling northward a short distance west of the Missouri River. The camp of the previous night was on the north bank of the Cannon Ball River. "In the course of this forenoon we observed three rattlesnakes of an entirely new and undescribed species: one of them I killed, and carried in my shot-pouch, and during the time we stopped to feed our horses, I secured the skin." This locality would be somewhere near the southeastern corner of Morton County.

The next record is possibly that of Allen (1874, p. 69) for 1873 under the name of *Caudisonia confluenta*: "Common, especially in the Badlands of the Little Missouri and along the Yellowstone. This species many times outnumbers all the other Ophidians together. Several hundred were killed by the different members of the Expedition, but notwithstanding its abundance the only casualty resulting from it was one horse bitten. On the Expedition of 1872 they were found in much greater abundance than on the present one. It was estimated that on the Expedition of 1872 not less than *two thousand* were killed, and yet not a man nor an animal was bitten by them. This shows how little danger there really is from them, even when numerous. Man is a far more fatal enemy to the snake than the snake is to man. I was surprised to find how late in the season they are found abroad, as we met with them quite frequently after several severe frosts had occurred. During July two pairs were found *in coitu*, indicating the season at which they pair."

Young (1924b, p. 56) refers to this as "of southern distribution" and (p. 59) as a "characteristic plains species." "Rattlesnakes (Crotalus confluentus), which were formerly characteristic animals in the Badlands, appear to be on the decrease." (p. 59).

Klauber (1936, p. 241 & map, p. 253) gives the range in the state as "southwestern North Dakota (west of the Missouri River but including the first tier of counties on the eastern bank)."

Gloyd (1940, p. 213) gives as the range for the subspecies: "The Great Plains region of North America from southeastern Alberta and southwestern Saskatchewan to northeastern Sonora, northern Chihuahua, and west-central Texas; from the Rocky Mountains eastward through the central portions of North and South Dakota and north-central Nebraska to extreme western Iowa, central Kansas, and western Oklahoma. Toward the west it has spread through gaps in the Rocky Mountains to eastern Idaho (Lemhi Valley), southeastern Utah, and northeastern Arizona." His map (p. 213) shows the range in the state as south and west of the Missouri River and also the counties on the eastern bank.

Schmidt and Davis (1941, p. 309) map the state range as Klauber does.

The following records are all southwest of the Missouri River.

NORTH DAKOTA RECORDS.—*Billings County:* Medora, collected by N. A. Wood, June 19, 1921 (UMMZ 56250); Petrified Forest, collected by Mr. Olson (UMMZ 56904); Mikkelson, collected by J. E. Goldsberry, September 1932 (UND); T. 144 R. 102, collected by J. E. Goldsberry (UND).

Morton County: Palace Butte 6 miles N. of Cannon Ball, collected by H. H. Sheldon, August 19, 1915 (USNM 53066); Mandan (UND); near S.E. corner of county (Bradbury, 1819, p. 147).

Slope County: Little Missouri River 4 miles below Marmarth, collected by Hubbs & Schultz, June 10, 1922 (UMMZ 65056); near Amidon, collected by R. N. Bach (UND).

Uncertain records: rattle referred to by Captain Meriwether Lewis (Thwaites, 1904, p. 257-258; see above); "Badlands of the Little Missouri," probably in Billings County (Allen, 1874, p. 69).

13. CHELYDRA SERPENTINA SERPENTINA (Linnaeus)

Snapping Turtle—Young (1924b, p. 62) mentions this species as occuring in the state.

Breckenridge (1944, p. 160, map 38) and Conant (1938, p. 125, map 30) include the whole of North Dakota in the range of this turtle.

NORTH DAKOTA RECORDS.—*McHenry County:* Towner, collected by N. A. Weber, July 1930 (UND).

Pembina County: Walhalla, collected by Norman Gluckman, summer 1940 (UMMZ 90203).

14. CHRYSEMYS BELLII BELLII (Gray)

Western Painted Turtle—Allen (1874, p. 68) reported this turtle (under the name of *C. oregonensis*) "near Fort Rice and in the vicinity of Heart River, near pools of water in the prairies."

Coues and Yarrow (1878, p. 259) under the name of *C. oregonensis,* record it from "Mouse River, Dakota, August 30, 1873."

Young (1924b, p. 62) mentions it (under the name of *C. marginata*) as occurring in this state.

Hankinson (1929, p. 444) states that "only a few painted turtles (*Chrysemys*) were seen." No localities are mentioned.

Telford and Stevens (1942, p. 32) state that "painted turtles (*Chrysemys bellii bellii*) were often found and were particularly abundant at Strawberry [Lake]."

Breckenridge (1944, p. 179, map 43) includes the whole of North Dakota in the range of *C. bellii s. lat.* but does not differentiate subspecific ranges.

The following records suggest a wide range in the state, but there is no record from the territory southwest of the Missouri River.

NORTH DAKOTA RECORDS.—*McHenry County:* 8 miles N. of Towner, collected by R. Kellogg, July 28, 1915 (USNM 53039-40).

Bottineau County: 8 miles N.W. of Kramer, collected by C. J. Henry, May 18, 1936 (UMMZ 80535).

Bottineau County or *Rolette County:* Turtle Mountains, collected by Mr. Eastgate, October 1919 (UMMZ 53296).

McLean County: Strawberry Lake, 1940 (Telford & Stevens, 1942, p. 32).

Morton County: near Fort Rice, 1873 (Allen, 1874, p. 68).

Richland County: Wahpeton, collected by R. Kellogg, June 5, 1915 (USNM 54382-4).

Rollette County: (See Bottineau County).

Ward County: Mouse River at Minot, collected by Wesley Dayton, summer 1932 (UMMZ 74347).

Williams County: 4 miles W. of Grinnell, collected by R. Kellogg, August 30, 1915 (USNM 54333).

Uncertain records: Souris River (Mouse R.), collected by E. Coues, 1873 (USNM 013821- "fragments"); Mouse River, August 30, 1873 (Coues & Yarrow, 1878, p. 259); "vicinity of Heart River," 1873 (Allen, 1874, p. 68); Sheyenne River, collected by Mr. Eastgate, July 26, 1919 (UMMZ 53806-07).

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DEPARTMENT OF BIOLOGY,
UNIVERSITY OF NORTH DAKOTA,
GRAND FORKS, NORTH DAKOTA.

Torpidity in Birds

W. L. McAtee

On October 14, 1902, a date later than the bird had been previously reported from the State, I found a chimney swift clinging to the bark of a tree in Bloomington, Indiana. Though quite numb when picked up, it quickly recovered and became active in a warm room. That experience gave me an interest in avian torpidity which stimulated the collection of references on the subject. The results of these are summarized in the present paper.

The rigidly scientific ornithologist is likely to doubt the occurrence of torpidity and especially hibernation in birds, but Thomson and Geddes (1931) say, "We are not aware of any *á priori* reason why birds should not hibernate." It may be worthwhile to mention that 1) numerous kinds of bats and insectivores are no more prone to accumulate fat than are most birds, and 2) many of these (bats and insectivores) when active possess body temperatures which are almost as high as those of birds. Nevertheless many of these mammals are reliably known to undergo long periods of torpidity.

In addition to the above experience I observed at a resort (Fairfax County, Virginia, 1942) a swift in the smokepipe of a water-heater several feet distant from the chimney through which it entered. It might have been in this place for a short time but it could have been there for several days since it appeared disheveled and moribund. In order to provide an opportunity for its recovery I laid it on the roof of an entry-way which was exposed to the sun. As soon as I put it down it took to wing and flew strongly, though a little haphazardly, away. That was the second torpid swift I had handled and when others relate similar experiences, I am inclined to take their statements at face value.

Scott (1884) records that J. F. Whiteaves (Paleontologist and Zoologist to the Geological Survey of Canada) observed a swift to emerge from a chimney and enter a room where he was sitting in Ottawa in February, 1883. The specimen, caught and examined by Mr. Whiteaves, remained alive for several days. All parties to this account were highly reputable and there can be no doubt about the occurrence (see also Lees, Kingston, and Macoun 1891).

In 1914, James A. Steele (Cashier of the Merchants and Farmers State Bank, Sullivan, Illinois) wrote to the Biological Survey with regard to the chimney swallow, as follows: "In our house there is a large chimney which has been the nesting place for these birds for over thirty years. . . . This chimney has always been used for a wood or soft coal fire until we put up a base burner. One evening it began to 'gas' so badly that we had to shut it off and go to bed. The next morning we took it down and found, lodged in the elbow of the pipe, seven full grown swallows which were dead, having evidently been suffocated by the gas. This would look as though they hibernated in this climate."

The above reports are from laymen but Charles Conrad Abbott a recognized ornithologist (1884) wrote, "In December, 1879 [i.e. when he was 36 years old], I had occasion to have a wood-stove removed from a fireplace, and one for burning coal put in its place. The removed stove had not had a fire in it for nearly a year. On detaching the pipe, there were found seven swallows in one of the elbows, occupying the space between the angle and the damper. They were all perfectly well and comparatively vigorous. On being placed upon the floor of the room, they soon recovered their full senses, and, after a feeble flight about the room, passed quickly through an open window and were seen no more. The great bulk of the chimney-swallows apparently departed by the 25th of October of that year. I certainly saw none later; yet fifty-five days after that date seven were found, in fine health and strength, snugly stowed away in a stove-pipe. It is fair to suppose that they had lived for this length of time without food. If so, have we any right to limit the length of time that they may thus remain in a semi-torpid or hibernating condition? To maintain that such a question is reasonable is not an attempt to carry water upon both shoulders; for swallows' hibernation in sheltered places, surrounded by the atmosphere, is vastly different from lying in mud at the bottom of a lake or the ocean. In a second somewhat similar instance that has come to my knowledge, a number of these birds were found in a hollow sycamore which was cut down in the month of February. These birds were dead when I saw them, and I was assured by the wood-cutter that they were stiff and cold when he took them from the tree. They were not frozen, however, and the appearance, on dissection, was such as to lead to the belief that they had died but very recently; certainly before the tree was cut down, but not long previously. There was no decomposition; some trace of fatty tissue, and the blood liquid; the bowels and stomach empty, but moist, soft, and flexible. In this case, happening during a remarkably mild winter, that of 1879-'80, it is possible that swallows might survive in such quarters, when a season of ordinary severity would destroy them."

From the above it seems clear that torpidity from brief to extended periods is possible in the chimney swift and that under favorable circumstances, hibernation seems a possibility. Wilson C. Hanna (1917) traced similar evidence for the phenomenon in the white-throated swift a bit farther. Writing of birds on Slover Mountain near Colton, San Bernardino County, California, he stated: "During the extremely cold wave of early January, 1913, eight, to me perfectly healthy, swifts were taken out of a crevice where they, with many others, seemed to be roosting in a dazed or numb state. They were kept in a room for about six hours and then turned loose, one at a time, a few hundred feet from the point where they were captured. All flew away in a dazed fashion and nearer the ground than usual and none were observed to return to the place where they were captured. I had hitherto thought that they were numb from the cold, or possibly from the jar of a blast in their immediate vicinity; but it has been suggested to me that possibly they were hibernating. This raises a very interesting question, as it seems possible that these birds have intermittent hibernation periods. The facts are that these

birds are not observed for many days in the coldest weather, yet are found to be plentiful within the rocks, in a dormant state."

In the hummingbirds, usually considered in the same order with the swifts, death-feigning occurs. Exactly when the duration of feint is sufficient for recognition of a condition of torpor is debatable. Wilson (1810) described recovery from such a condition that lasted half a day and keepers of live hummingbirds are well aware of a proneness to torpidity among these forms (Gould 1861, Chaplin 1933, and Huxley, Webb, and Best 1939). Chaplin wrote of one bird that was "torpid successively for 17, 15, and 20 hours within four days."

Some of the apocryphal stories in this field pertain to hummingbirds and swifts but the largest single component of the literature relates to swallows. Again selecting the most credible accounts and leaving the others (the great majority) for mention only in the bibliography, we may cite the following. That swallows sometimes become torpid in cold, rainy weather has been recorded by Rohweder (1877), Lorenz (1932), and Keyserlingk (1937). Lorenz, a respected ornithologist, states that he repeatedly observed this phenomenon in birds congregated in sheltered places prior to their finally perishing. Yet birds removed from the masses revived and flew with their usual skill. Some of these aggregated swallows were collected and shipped back to Italy by airplane; an incident which received much newspaper publicity at the time. How long swallows can remain torpid and yet recover from that state is a question which existing accounts fail to answer. Some of the records while deficient in this particular, are as authoritative as many bits of generally accepted knowledge and apparently indicate genuine winter dormancy. Sir John McNeill (1877) relates that he and Sir Henry Rawlinson found in a land-slip along a stream in Persia during a frost of unusual severity, "a number of swallows, not less, I am sure, than twenty or thirty lying, as I at first supposed, dead, but on taking up one of them I found that it was alive but dormant; it was warm and its breathing was quite perceptible. I examined a considerable number and found that they were all alive and breathing, but none of them showed any sign of consciousness." He found additional dormant swallows in other holes and formed the opinion that they may have totalled "many hundreds." Swallows lethargic in winter have been reported from Argentina; in a burrow by Lugones (1932), in a chimney by Castellanos (1921), and under a roof by Spegazzini (Salvadori 1889). These records seem entirely credible but where to draw the line between the valid and invalid accounts is difficult. Thus B. S. Barton (1802) states, "Judge Peters informed me, at Lancaster [Pa.] in 1802, that he has in different years, during the winter-season found the Common Martins (*Hirundo purpurea*) in the clefts of a 'granite' quarry, upon the place which he resides. They were (he said) always in a torpid-state, quite stiff, and he has recovered them by putting them to the fire. On one occasion, he found about half a dozen of them, 'in a bunch'."

A reference that I have seen in the original but unfortunately mislaid is here cited at second hand from Chastellux (1787). It involves historical personages and can hardly be dismissed as fanciful, yet it brings us to the

brink of acceptance of the whole lore of hibernation of swallows in dry places. The account is: "Mr. Fleming, Chief Justice of Virginia, a man worthy of credit, and reputable in every point of view . . . assured Mr. Jefferson, that on a winter's day, as he was occupied in superintending the felling of some trees . . . he was surprised to see fall, with a large cleft oak, a great number of martins, which had taken refuge and were benumbed in the crevice of the tree, as bats are found in holes of rocks and caverns." (p. 423.) In regard to wet torpidity, Samuel Williams (1794) says, "I saw an instance, which puts the possibility of the fact beyond all room for doubt. About the year 1760, two men were digging in the salt marsh at Cambridge, in Massachusetts: On the bank of Charles river, about two feet below the surface of the ground, they dug up a swallow, wholly surrounded and covered with mud. The swallow was in a torpid state, but being held in their hands, it revived in about half an hour. The place where this swallow was dug up, was every day covered with the salt water, which at every high tide was four or five feet deep. The time when this swallow was found, was the latter part of the month of February; but the men assured me, they had never found any other swallows in such a situation." (p. 116.) This account differs in no important way from those recited in complete acceptance of the subaqueous hibernation of swallows (supported by numerous affidavits) by Klein (1750), a leading ornithologist of his period.

Ptarmigans (and related species) also are cited in the hibernation literature. The older accounts (Magnus 1658; Pontoppidan 1755) seem less credible and approximately so in proportion to their antiquity. However, Nordenskiöld (1881) wrote of rock ptarmigans in Spitzbergen "creeping in among the stones [to] pass the winter there, at certain seasons doubtless in a kind of torpid state" (p. 130). These were birds upon which he and other men in part subsisted. An indication of the validity of the account lies in the statement that they collected two hundred of these birds during the winter. Bertram, Lack, and Roberts (1934, p. 829) state that the willow grouse in Greenland "retires beneath the snow in winter." In a letter of November 20, 1942, Roberts of this trio interprets this statement to mean "that they merely shelter, possibly for long periods, in holes which they dig for themselves in the snow."

Lawson (1860) and Bartram (1793) were told of hibernation of parakeets in Carolina and there are references to the same trait in other localities, the most circumstantial relating to Indiana. The two narrators, Amos Butler and John Collett (Butler 1892) state they were told that, "In 1842 Return Richmond, of Lodi, Indiana, cut down, in the cold weather of winter, a sycamore tree some four feet in diameter. In its hollow trunk he found hundreds of Parrakeets in a quiescent or semi-torid condition. The weather was too cold for the birds to fly or even to make any exertion to escape. Mr. Richmond cut off with his saw a section of the hollow trunk some five feet long, cut out a doorway one foot by two in size, nailed over it a wire screen of his fanning mill, rolled this cumbersome cage into the house, and placed in it a

dozen of the birds. . . . At night they never rested on a perch, but suspended themselves by their beaks and with their feet on the side of the cage." (p. 53.)

We may conclude from this literature review and the notations in the references that 1) various birds can enter into, and survive, a torpid state and 2) accounts by apparently reliable persons indicate that torpidity may be sufficiently prolonged to be recognized as a condition of hibernation. From this point the story is less clear and there is no definite evidence, so far as the writer is aware, that any bird can survive a full season of genuine hibernation.

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2. [ABBOTT, L. S.] 1877—Do birds hibernate? The Country **1**(5):55.—Large number of swallows found in a hollow tree in winter. Eye-witness.

3. [———] 1878—Hibernation of birds. The Country **1**(13):165.—The "swallows" were chimney swifts, and while he cannot assert, he believes, that they were alive, though torpid. He thinks bluebirds also remain over winter in hollow trees.

4. ACHARD 1764—Remarks on swallows on the Rhine . . . in a letter . . . to Mr. Peter Collinson, F. R. S. Roy. Soc. Lond. Philosophical Transactions **53**(1763):101-102.—Below Basil boys were seen probing holes in a cliff. They were in search of swallows or martins of which this writer states that he obtained some which seemed stiff and lifeless, but were revived by warming.

5. ALBERTUS MAGNUS 1495—Divi Alberti Magni de Animalibus libri vigintisex novissime impressi. Venice.—The European cuckoo lies hid during winter in tree and rock cavities and sheds its feathers.

6. ALDROVANDUS, ULYSSES 1610—Ornithologiae hoc est de Avibus historiae. Bologna.—Allegations as to hibernation of cuckoo and swallows from "authorities" (books 5, 17).

7. ANONYMOUS 1745—A new general history of birds, etc. London.—Quotations from older authorities, all favorable to the torpidity hypothesis: swift, swallow, cuckoo (**2**:237-239).

8. ANONYMOUS 1800—On the submersion of swallows. Medical Repository **3**:241-246.—Reply to Cole (q.v.), citing arguments against the possibility of swallows hibernating under water. Thinks there may have been an error of observation as to swallows submerging. Moreover swallows migrate.

9. ANONYMOUS 1840—Natural history of birds. Their architecture, habits, and faculties. New York.—Abridged from Rennie 1835, q.v.

10. ANONYMOUS [presumably Bowen, Henry C., editor] 1875—[Hibernation of chimney swift]. The Independent (New York) **27**(1401):8.—Notes lack of information as to winter home; describes gatherings in hollow trees; warns against hasty conclusions.

11. ANONYMOUS 1877—Do birds hibernate? Popular Science Monthly Supplement **3**:287.—Allusion to the Sir John McNeill article in Nature.

12. ANONYMOUS [B——, S. B.] 1878—[Hibernation of swallows]. The Country **1**(11):133.—Quoted from Portland (Maine) Transcript. Second-hand account of thousands of swallows being found in the mud of a drained mill pond in Massachusetts in winter. For additional comment, see p. 181.

13. ANONYMOUS (M.)—1881—[Mud-inhabiting swallows]. Forest & Stream **17**(15): 289.—Great numbers of swallows clinging with their bills to branches [roots] of willows under water. Extract from a letter by one of our oldest diplomats.

14. ANONYMOUS (C. H.) 1885—Submersion of swallows. The Young Oologist **2**(1): 9.—Copy of news item to the effect that it was observed at Hudson [Conn.?], Aug. 4, 1802.

15. ANONYMOUS (A. O. U.) 1909—A hibernating hawk. Emu **8**(4):225.—Quotes from Cape Colony Agricultural Gazette for December 1908 about a brown hawk [possibly *Milvus aegyptius*] that stores locusts and other food, sheds its plumage, and becomes dormant in winter.

16. ANTES, FREDERICK 1809—[On the hibernation of swallows]. Trans. Amer. Phil. Soc. **6**:59-60.—One swallow personally retrieved from muck in February revived; similar observations later made; the whole rendered incredible by the assertion that a revived swallow kept alive on flies in a house from February until the spring migrants came.

17. ARISTOTLE [384-322 B.C.] 1862—History of animals. Translated by Richard Cresswell. **8**:215.—Birds of at least 8 species alleged to become torpid briefly or longer, mostly shedding their feathers.

18. [ASH, THOMAS] 1836—Carolina, or a description of the present state of that country, etc. London, 1682. Reprint, Hist. Coll. South Carolina **2**:74.—As to hummingbirds, "I am informed, that in the more northern parts of America, they sleep the whole winter."

19. AUDUBON, JOHN J. 1824—Facts and observations connected with the permanent residence of swallows in the United States. Ann. Lyceum Nat. Hist. N. Y. **1**:166-168.—Same material as in Birds of America, 1, 1840, pp. 179-180.

20. ———1840—Birds of America. **1**:1-246.—From observations upon a "swift tree" in Kentucky (p. 168), and upon tree swallows in Louisiana (pp. 179-180) in winter, he concludes that neither hibernate.

21. BACHMAN, J. 1836—On the migration of birds in North America. Amer. Jour. Sci. & Arts **30**:81-100.—Many believe that soras hibernate but they migrate. Swallows and swifts have been found temporarily torpid but they are not physiologically capable of hibernation (pp. 94-96).

22. BALLOU, WM. H. 1880—On the torpidity of animals. Amer. Nat. **14**:130-132.—Second-hand account of swallows being found in a hollow tree in April; many took life and flew away.

23. BARRINGTON, DAINES 1772—An essay on the periodical appearing and disappearing of certain birds, at different times of the year. Roy. Soc. London Philosophical Transactions **63**:265-326.—Reproduced in his "Miscellanies," 1781, q.v.

24. ———1781—Miscellanies.—Review of instances and experiments, *pro et con re* bird hibernation; this compiler is a believer; he gives the following number of first-hand accounts of torpidity in *Hirundo rustica*, *H. urbica*, and *H.* spp.—4, 4, 1; and of second-hand reports, 7, 7, and 3, respectively.

25. BARTON, BENJAMIN SMITH 1794-1802—Journals. Historical Society of Pennsylvania, Philadelphia.—Torpidity of bank swallow and hibernation of the Carolina paroquet and purple martin recorded on the testimony of acquaintances.

26. ———1805—[Letter to M. Lacépède, of Paris, on the Natural History of North America]. Tilloch's Philosophical Mag. **22**:97-103; 204-211.—It is now completely ascertained that some of the American species of swallows [and also

the hummingbird] though normally migrating, sometimes remain among us in a torpid state.

27. ———1807—A discourse on some of the principal desiderata in Natural History, etc. Philadelphia.—Hummingbirds are susceptible of the torpid state and have been found torpid in Pennsylvania and Maryland; refers to the accounts of Herrara and Ximenez [from de Laet] about Mexican hummers (p. 90); queries as to hibernation of other species (pp. 21-22).

28. ———1810—On the torpidity of animals. Tilloch's Philosophical Mag. **35**:241-247.—Notes on the phenomenon in American birds; "there is no fact in ornithology better established" than the occasional torpidity of the bank swallow and the chimney swift. This is the fullest and most thorough of the Barton contributions.

29. ———1815—Letters. Historical Society of Pennsylvania, Philadelphia.—In a "Memo. at Princeton respecting letter to M. Cuvier," he notes that experiments under his direction at the Pennsylvania Hospital have still further established that the Hummingbird is truly susceptible of the torpid state.

30. ———1883—Fragments of the Natural History of Pennsylvania (1799) XII, 16-19.—Alleged hibernation of four or more species reported at secondhand.

31. BARTRAM, WM. 1793—Travels through North and South Carolina, Georgia, East and West Florida, etc. Dublin.—Parakeets. "I was assured in Carolina, that these birds" hibernate in hollow cypress trees for a month or two in the coldest part of the winter. Bartram was never witness to it, but does not doubt that there have been instances. (p. 299.)

32. BEESTON, HARRY 1907—Observations of an attempt of the swallow tribe to winter in South Hants during 1906-7. Zoologist **792**:233-234.—A common swallow (*Hirundo rustica*) apparently had spent 10 days in December in a torpid state, then revived and flew.

33. BERGER, KARL 1926—Der Winterschlaf die Vögel. Orn. Monatschr. **51**(11): 193-203.—Reviews traditions as to a number of birds; the belief in hibernation of swallows is very widespread; cites a number of authorities for torpidity in swallows; the fact that cold-stiffened swallows can be brought to life makes it possible that a kind of hibernation really exists among them.

34. BERTRAM, G. C. L., DAVID LACK, AND B. B. ROBERTS 1934—Notes on East Greenland birds, with a discussion of the periodic non-breeding among Arctic birds. Ibis 13th Ser. **4**(4):816-831.—"The willow grouse . . . retires beneath the snow in winter" (p. 829). Roberts writes me that the period is unknown and it may be long. (Nov. 20, 1942.)

35. BEWICK, THOMAS 1797—History of British birds.—Reports experiments by James Pearson in keeping swallows over winter; they did not become torpid (**1**:335).

36. BONNATERRE, J. P. AND L. P. VIEILLOTT 1823—Tableau encyclopédique et methodique des trois règnes de la natur. Ornithologie **2**:522.—Refers to Chatelux (see Chastellux of this list), Pallas, and Spallanzani as giving evidence in favor of bird torpidity.

37. BOOTH, E. J. 1881-87—Rough notes on the birds observed during 25 years' shooting and collecting in the British Islands. **1** (neither pagination nor plate numbering in this work).—Belated swallows may become torpid but it is "extremely doubtful if a single individual ever survives the winter." The belief, however, still prevailed in his time.

38. BOSTOCK, JOHN, AND H. T. RILEY (translators) 1855—The natural history of Pliny. London. In Vol. 2 is reference to winter concealment of the swallow (p. 505) and the turtle dove (p. 506).

39. BREE, W. T. 1829—On the arrival and retreat of the British Hirundines with a table of arrivals and departures, from 1800 to 1828. Loudon's Mag. Nat. Hist. **2**:16-20.—Refers to Gilbert White's views but notes that there is no well authenticated report of the discovery of dormant swallows.

40. BRUYN, SEVERYN J. 1793—[A letter on the retreat of swallows, and the torpid state of certain animals in winter]. Mem. Amer. Acad. Arts & Sci. **2**(1):96-99.—Personally saw thousands of chimney swifts, all dead, in a hollow tree in March, N. Y.; newspaper account of a similar finding of barn swallows.

41. BUFFON, COUNT DE 1793—The natural history of birds. Transl. by Wm. Smellie. London.—Hernandez report of torpidity in hummingbirds (**6**:1); review of literature on the hibernation of swallows (**6**:469-485); "the submersion of swallows appears by no means ascertained"; Edwards' supposition as to torpidity of the razor-billed auk (**9**:33).

42. BUTLER, AMOS W. 1892—Notes on the range and habits of the Carolina parrakeet. Auk **9**(1):49-56.—Third-hand account of hundreds of parakeets being found in a hollow sycamore in winter near Lodi, Indiana. Some of them were kept alive indoors for an extended period.

43. CAREW, RICHARD 1602—The survey of Cornwall. London.—Second-hand reports on winter "lurking places" of swallows.

44. CASTELLANOS, ALBERTO 1921—Las golondrinas emigran o se aletargan en el invierna? El Hornero **3**(2):228.—Personal observation of swallows in Argentina in winter.

45. CATESBY, MARK 1791—Natural history of Carolina, Florida, and the Bahama Islands, etc. London.—Quotes "Hernandes" on torpidity of hummingbird **1**:65.

46. CHAPLIN, ANTHONY 1933—Of Fable and Fact. Avicultural Mag. Ser. 4, **11**(8): 209.—Hummingbirds become torpid.

47. ———1933—Torpidity in the Trochilidae. Avicultural Mag. Ser. 4, **11**(8): 231-232.—Not due solely to lowering of temperature; may be response to a need for profound rest; it "must be termed 'partial hibernation'."

48. ———1933—Humming birds. Avicultural Mag. Ser. 4, **11**(12):431-434.—If turned upside down while in the torpid state, may remain in that position clinging to the perch with the feet like a bat.

49. CHASTELLUX, F. J. (MARQUIS DE) 1787—Travels in North America, in the years 1780, 1781, and 1782. Transl. from the French. London.—Quotes Fleming's statement to Jefferson about finding a great number of martins in a cleft oak in winter (**2**:423-424).

50. CLARKE, SAMUEL 1671—A mirrour or looking-glass both for saints and sinners, etc. London.—"Examples of the Wonderful Works of God in the Creatures"; one of the appendixes, 35 pp., contains on p. 23 references to the legend as to six-months' sleep of hummingbirds.

51. CLAVIGERO, D. FRANCESCO SAVERIO 1787—The history of Mexico. Transl. by Charles Cullen.—In some countries, the hummingbird remains without motion from October to April; torpidity has been attested in legal form (**1**:51-52).

52. CLEGHORN, ALLEN 1911—Hibernation. Science N.S. **34**(877), Oct. 20, pp. 513-514.—Quotes C. W. Nash on dormancy in purple martin, chimney swift, and "swallows" in Ontario.

53. CLINTON, DEWITT 1824—On the Hirundo fulva of Vieillot, with some general remarks on the birds of this genus. Ann. Lyceum Nat. Hist. N. Y. **1**:156-166. —The birds migrate, not hibernate.

54. COLE, PETER 1799—[On the disappearance of swallows in Autumn]. Tilloch's Philosophical Mag. **4**:414-417.—Reprint from Amer. Medical Repository, doubtless from the first edition; with editorial comment: "there seems to be positive evidence" of hibernation.

55. ———1800—On the disappearance of swallows in autumn. Medical Repository **2**:167-170.—He and a friend saw swallows submerging in a pond; quotes accounts of barn swallows torpid in a hollow tree, and of swallows being found in the mud of a drained pond.

56. COLLINSON, PETER 1761—A letter to the Honourable J. Th. Klein . . . concerning the migration of swallows. Roy. Soc. Lond. Philosophical Trans. **51**(2):459-464.—Points out lack of adaptation of swallows to respiration under water. All the conditions Klein describes characterize the Thames River but no swallows have been found there. Excavation of bank swallows' nests in autumn revealed no birds.

57. CORNISH, JAMES 1775—Of the torpidity of swallows and martins . . . in sundry letters to the Honourable Daines Barrington, etc. Roy. Soc. Lond. Philosophical Trans. **65**:343-352.—Second-hand references to martins, swifts, and cuckoo.

58. COUES, ELLIOTT 1878—Migration of swallows, in Birds of the Colorado Valley. U. S. Geol. Survey Terr. Misc. Publ. **11**:372-390.—Mostly a discussion of hibernation; an annotated bibliography occupies pp. 378-390. "The evidence has never been successfully refuted or satisfactorily explained away." (p. 375.)

59. ———1927—Key to North American birds.—Says of *Chaetura pelagica*, "In districts still primitive, however, it continues to use hollow trees, to which it resorts by thousands to roost. Not impossibly winters in such retreats in a lethargic state!" (**2**:560.)

60. [CUTLER, JERVIS] 1812—A topographical description of the State of Ohio, Indiana Territory, and Louisiana, etc. Boston.—Parakeets retreat to hollow trees in winter.

61. DERHAM, W. 1779—Physico-theology: or a demonstration of the being and attributes of God, etc. Edinburgh.—Refers to the accounts of swallow submersion by Magnus and Ettmuller (see Rennie) and gives in some detail three eye-witness observations by Dr. Colas conveyed to the Royal Society, Feb. 12, 1712.

62. DEXTER, SAMUEL 1785—[A letter on the retreat of house-swallows in winter]. Mem. Amer. Acad. Arts and Sciences **1**:494-496.—Hearsay as to swallows being found in the bottom of a drained pond; personal testimony as to swallows being seen slimy and sluggish in spring.

63. DOVE, H. STUART 1926—Winter swallows. Emu **26**(2):138.—*Hirundo neoxena*. Appearance in midwinter in good condition, suggesting hibernation.

64. DUPOND, CH. 1937—L'engourdissement des Hirondelles. Le Gerfaut **27**(4):226-227.—Quotes Lorenz (1932) and Keyserlingk (1937); nothing original; the phenomena cited give substance to the old belief that swallows hibernate in caves and rock crevices.

65. DU TERTRE, JEAN BAPTISTE 1567-71—Histoire generale des Antilles habitées par les Français. Paris.—Information on torpidity accepted for swallows because they are so much more numerous in cold than in warm regions. He did not see them in the Antilles during the time they are absent from the north. Personally found a hummingbird with its bill stuck in bark; it escaped after he had plucked it (**2**:259-265).

66. DUTROCHET, H. 1938—Hibernation des hirondelles. Comptes rendus . . . Acad. Sci. Paris **6**:673.—He saw two torpid swallows removed from a wall in midwinter and revived in the hands so that they flew.

67. EKMARCK, C. D. 1759—Migrationes avium. Amoenitates academicae (C. Linnaeus).—The hibernation of the European swallow, martin, and cuckoo is asserted and that of the swift reported as popularly narrated (**4**:565-600).

68. ELLICOTT, ANDREW 1808—Hints relative to swallows. Philadelphia Medical and Physical Journal **3**(1), Second Suppl. Section **1**:116-118.—Quotes Regnard on underwater hibernation of swallows in Lapland, Sweden, and Denmark.

69. ELLIOT, JONATHAN 1830—Historical sketches of the Ten Miles Square forming the District of Columbia, etc.—Hibernation of sora and swallow "scarcely credible" (p. 445).

70. ELLMAN, J. B. 1848—Swallows (Hirundo rustica) dug out of hedge-banks. Zoologist **6**:2302-2303.—Hearsay.

71. FITTON, EDWARD B. 1849—Swallows hibernating in the cliff at Hastings. Zoologist **7**:2590.—Three railway-barrows full of them, apparently dead; hearsay.

72. FLAGG, WILSON 1875—The birds and seasons of New England.—Hibernation of swallows, pp. 262-266. Reviews the accounts of White and Barrington; thinks the greatest burden of proof remains with those who maintain the theory of migration.

73. FLEMING, JOHN 1822—The philosophy of zoology, etc. Edinburgh.—Rejects swallow immersion but admits that occasional torpidity in the nests probably is a fact. Quotes others on torpidity in the cuckoo and corn crake (**2**:71-74).

74. FORSTER, GEORGE 1787—A voyage round the world, etc.—At Madeira, swallows and swifts in very cold weather retire to crevices in rocks and return the first, fair, sunny day (**1**:25-26).

75. FORSTER, THOMAS 1814—Observations on the brumal retreat of the swallow. 4th Edit. Reprinted in The Pamphleteer **4**(8):451-462.—Review of the literature; swallows usually migrate, sometimes become torpid, but probably do not successfully hibernate.

76. GESNER, CONRAD 1617-21—Historiae animalium. Frankfort. Liber III qui est de avium natura.—Accounts of hibernation of storks, cuckoo, quail, and swallows from older authors (pp. 232, 322, 493).

76a. GOSSE, PHILIP HENRY 1861—The romance of natural history. Second series. London.—A section, "Hybernation of Swallows" (pp. 191-210), reviews literature, most of which is cited in the present bibliography, rejects subaqueous hibernation, but says there seems no room for reasonable doubt that swallows remaining late have entered torpidity from which they recovered and became active. Whether the torpid period ever extends through the whole winter remains to be elucidated.

77. GOULD, JOHN 1848—The birds of Australia. London.—In text accompanying Pl. 3 (Vol. 1) he mentiones that the Podargi are very lethargic and that their hibernation has been reported to him.

78. ———1861—A monograph of the Trochilidae. **1**:xviii.—Records recovery of hummingbirds from torpidity induced by cold.

79. HANNA, WILSON C. 1917—Further notes on the white-throated swifts of Slover Mountain. Condor **19**(1):1-8.—Possible hibernation; eight dazed or numb birds taken from a rock crevice in January, revived and flew.

80. HARTING, JAMES E. 1906—Recreations of a naturalist. London.—Discounts notions as to hibernation of swallows; describes migrations of these birds.

81. HERNANDEZ, FRANCISCO 1651—Nova plantarum animalium et mineralium mexicanorum historia. Rome.—Hummingbirds remain torpid six months and revive. This is in a section ascribed to Antonio Recchio, but the whole work is customarily cited as of Hernandez (pp. 321-322).

82. HEUMANN, G. A. 1926—Mistletoe-birds as plant distributors. Emu **26**(2):110-111.—*Dicaeum hirundinaceum;* after remaining cold torpid for days, can be revived by warmth. Both first- and second-hand information.

83. HUDSON, WM. H. 1901—Birds and man.—Hibernation of swallows (pp. 300-301); torpidity alleged by two recent authors "the old controversy is not quite dead yet." In the 1923 edition, the same material is on pp. 249-250.

84. HUGHES, G. 1750—The natural history of Barbados.—Barn swallows in winter retire to holes in rocks and do not reappear (p. 73).

85. HUXLEY, J. S., C. S. WEBB, AND A. T. BEST 1939—Temporary poikilothermy in birds. Nature **143**(3625):683-684.—Torpidity in hummingbirds has been observed in captivity and in the field in Ecuador; it is known also among colies.

86. INGERSOLL, ERNEST 1923—Birds in legend and folklore.—Hibernation discussed, pp. 89-91; a century ago, "intelligent men abandoned the belief"; "unverified memorandum" as to torpidity of hummingbird in Mexico.

87. JONSTONUS, JOHANNES 1657—Historiae naturalis. Libri VI. De avibus. Amsterdam.—Compilation of older accounts of the hibernation of swallows (p. 83).

88. JOSSELYN, JOHN 1860—New-England's Rarities discovered. 1672 Reprint in Trans. & Coll. Amer. Antiquarian Soc. **4**:7.—Hummingbirds sleep all winter (orig. p. 7).

89. KALM, PETER 1772—Travels into North America. Trans. by J. R. Forster.—Cites accounts of swallows hibernating under water from Klein and Wallerius; some of these are supported by affidavits and Kalm accepts them; also thinks the birds may hibernate in holes in trees and cliffs (**2**:6-9).

90. ———1937—Travels in North America. (Trans. by A. B. Benson).—Refers to beliefs as to swallows lying at the bottom of the sea or sleeping in clefts of rocks in winter. (**1**:283.)

91. KEYSERLINGK, ALEXANDER (GRAF) 1937—Beobachtungen an uferschwalben (*Riparia riparia*). Ornith. Monatsber. **45**(6):185-188.—Gathering in torpid masses after a storm.

92. KLEIN, JACOB THEODORE 1750—Historiae avium prodromus, etc.—Subaqueous hibernation of swallows and storks discussed and firmly asserted on the basis of authorities and of affidavits of eye-witnesses.

93. LAET, JOANNE DE 1633—Novus orbis seu descriptionis Indiae occidentalis. Antwerp. **5**:256, (citation from B. S. Barton, Discourse, etc. p. 90).—Refers to the statements of Herrera (doubtless Hernandez) and Ximinez about torpidity in hummingbirds.

94. [LARREY, ——] 1838—Hibernation des hirondelles. Comptes rendus . . . Acad. Sci. Paris **6**:703.—Abstract of his account of finding swallows hibernating in a cave in southern France. The creatures seen probably were bats (**6**:703).

95. LAWSON, JOHN 1860—The history of Carolina, etc. Reprint; original published in 1714.—Torpidity of parrakeets reported (p. 234) and hibernation of bluebirds (p. 236).

96. LEA, ISAAC 1825—On hybernation. Amer. Jour. Sci. & Arts **9**:73-83.—Denies that it occurs in birds.

96a. LEES, WILLIAM A. D., A. G. KINGSTON, AND JOHN MACOUN 1891—The birds of Ottawa. Trans. Ottawa Field-Naturalist's Club **7**:31-47.—*Chaetura pelagica;* recounts the Whiteaves observation (Scott 1884) and adds, "A similar instance is known to have occurred in Toronto" (p. 41).

97. LEUNIS, JOHANNES 1860—Synopsis der Naturgeschichte des Thierreichs. Hanover.—No bird regularly hibernates but swallows occasionally do so; compiled information only.

98. LINCOLN, FREDERICK 1939—The migration of American birds. New York.—Brief discussion of hibernation (pp. 6-8); "it has never been scientifically proved for any species of birds."

99. LINNAEUS, C. 1758—Systema naturae, etc. **1**:191.—"Hirundo . . . rustica et urbica autumno demergitur, vereque emergit."

100. LORENZ, KONRAD 1932—Beobachtungen an Schwalben anläszlich der Zugkatastrophe in September 1931. Der Vogelzug **3**(1):4-10.—Swallows remaining torpid in masses during cold rainy weather; this may have given origin to the hibernation fable.

101. LOYD, L. R. W. 1927—Bird facts and fallacies. London.—Refers to belief in hibernation of the: corn crake (p. 228), cuckoo (122-123), gull (224), swallow (95-96), and turtle dove (201).

102. LUGONES, LEOPOLDO 1932—Sobre el letargo invernal de las golondrinas y picaflores. El Hornero **5**(1):85-88.—Said to be translated from Revue Sudamericaine (Paris) **6**:360-370. Personal experience in finding a torpid hummingbird and five hibernating swallows in winter in Argentina.

103. MCLEOD, ROBT. R. 1877—[Letter to the Editor on hibernation of birds]. Field and Forest **3**(2):35-36.—Second-hand accounts from witnesses (then living, however) of bank swallows being found torpid in mud (New Brunswick) and in a hollow tree (Maine) and being revived.

104. ———1903—Markland or Nova Scotia. Its history, natural resources, and native beauties.—"If reputable persons have not lied to me, then swallows do pass the winter like frogs." Chimney swifts also hibernate; hearsay (p. 528).

105. MCNEILL, JOHN (SIR) 1877—[Hibernation of swallows]. Nature **15**:527-528.—He and Sir Henry Rawlinson found hundreds of swallows dormant in burrows in Persia.

106. MAGNUS, OLAUS 1562—Historia de gentibus septentrionalibus. Antwerp.—The original edition, 1555. In this "De hirundinibus ab aquis extractis," pp. 155-156; "De avibus sub nive reclusis," p. 156.

107. ———1658—A compendious history of the Goths, Swedes & Vandals and other northern nations. Translated by J. S. London.—Swallows hibernating under water; the black grouse under snow; hearsay.

108. MARTIN, W. C. L. 1852—A general history of hummingbirds, or the Trochilidae: with special reference to the collection of J. Gould, etc. London.—Admits that torpidity may occur in moribund humming, and other, birds, but rejects avian hibernation.

109. MERRIAM, C. HART 1877-1882—A review of the birds of Connecticut, with remarks on their habits. Trans. Conn. Acad. Arts & Sciences **4**:31, 60-62.—Quotes Samuel Williams and Zadock Thompson (q.v.) on Swallow hibernation.

110. MORRISON, (MAJOR) 1823—Hybernation of the corncrake (Rallus crex). Edinburgh Philosophical Jour. **8**:414-415.—Three in a manure heap in Ireland; warmed, they revived and ran and flew about.

111. MORTON, ERLE 1893—What killed the swallows? Orn. & Ool. **18**(3):45.—An estimated fifty dead bank swallows found in a nest tunnel in May.

112. MYERS, J. C. 1849—Sketches on a tour through the northern and eastern States, etc. Harrisonburg.—A tavern host told of finding a thousand red-breasted (i.e. barn) swallows hibernating in sand near Plattsburg (presumably in New York). (p. 235.)

113. NELSON, E. W. 1883—Birds of Bering Sea and the Arctic Ocean. Exec. Doc. **105** 47th Congr., 2nd Sess.: 55-118.—Quotes Nordenskiöld on torpidity in subalpine ptarmigan. (p. 82).

114. NEWMAN, EDWARD 1813—A dictionary of British birds, being a reprint of Montagu's Ornithological Dictionary, etc.—Beliefs as to hibernation of swallows adversely discussed (pp. 200-201, 331).

115. NORDENSKIÖLD, ADOLPH E. 1881—The voyage of the Vega round Asia and Europe with a historical review of previous journeys along the north coast of the Old World. London.—Speculations on winter torpidity of dovekie and rock ptarmigan.

116. PACKARD, ASA 1793—[A letter on the retreat of swallows in winter]. Mem. Amer. Acad. Arts & Sciences **2**(1):93-95.—Two hearsay instances of swallows being found in mud in winter.

117. PALLAS, PETRO 1831—Zoographia rosso-asiatica, etc.—Second-hand reports of *Hirundo rustica* reviving from torpidity, and of submerging in the Volga River (**1**:530).

118. PENNANT, THOMAS 1786—British zoology. Warrington.—Discusses the evidence for torpidity in swallows; rejects that for wet, but accepts that for dry, situations (**1**:406-415).

119. PLINIUS, SECUNDUS [23-79 A.D.] 1635—The historie of the world; commonly called the Naturall historie of C. Plinius Secundus. Translated into English by Philemon Holland. London.—Fable about swallows hibernating naked **1**:283.

120. POLLOCK, H. 1800—[On the submersion of swallows in autumn]. Tilloch's Philosophical Mag. **8**:107-109.—Eye-witness observations, in part through a telescope; New York.

121. ———1808—On the submersion of swallows: In a letter to the Editor of the (New York) Monthly Magazine. Medical Repository **4**:215-216.—Eye-witness account, doubtless same as the preceding. Transmitted by W. Johnson, who says that the observers being men of undoubted veracity, the fact of *submersion* cannot be questioned. Torpidity and reappearance are separate questions.

122. PONTOPPIDAN, ERICH 1755—The natural history of Norway, etc. (Trans. from the Danish. Original publ. before 1753).—Torpid submersion of swallows referred to as an "incontestible truth" (p. 99); refers to hibernation under snow of the grouse (64) and ptarmigans (92).

123. PRAETORIOUS, JOHANNES 1676—Storchs v. Schwalben Winter-Quartier, etc. Frankfort and Leipzig.—Summary of the traditional lore, all statements of authorities apparently being accepted.

124. RAY, JOHN 1578—The ornithology of Francis Willughby, etc. London.—Reviews published statements on torpidity among swallows, cuckoos, and hummingbirds

(pp. 98, 212, 230), but says "I am not wont rashly or hastily to give credit to such relations."

125. READ, BERNARD E. 1932—Chinese materia medica. Peking Nat. Hist. Soc. Bul. **6**(4):1-112.—References to alleged hibernation of the black-naped oriole (p. 68) and the little cuckoo (p. 73).

126. REEVE, HENRY 1809—An essay on the torpidity of animals. London.—Reviews literature; says swallows disappear when the temperature is not cold enough to induce hibernation; that it is unlikely that the state could be assumed suddenly as in swallows plunging into water; they are known to migrate; other birds winter in the north but do not resort to hibernation (pp. 39-48).

127. [RENNIE, JAMES] 1835—The faculties of birds (Vol. III of the Library of Entertaining Knowledge). London.—Discusses bird hibernation rather fully (pp. 253-265) but rejects it. A good source for those who can not consult the originals for the statements of Aldrovandus, Olaus Magnus, Ettmuller, Derham, Klein, Cuvier, and others.

128. ROCHEFORT, CHARLES DE 1658—Histoire naturelle et morale des iles Antilles de l'Amerique.—Recounts tales of torpidity of hummingbirds but does not regard them as veritable history (p. 164).

129. ROGERON, GABRIEL 1897—L'Hibernation des hirondelles. Bul. Soc. Nat. D'Acclimatation de France **44**(2):51-58.—Proof is lacking; some of the alleged records probably refer to bats.

130. ROHWEDER, J. 1877—Ornithologische Notizen aus Schleswig-Holstein. **8.** Hausschwalben in Erstarrung. Orn. Centralblatt (Berlin) **(9)**:66-67.—Swallows torpid from cold 3-4 days could be revived; apparently those removed from nest-boxes recovered and disappeared.

131. SALVADORI, TOMMASO 1889—Hibernation of martins in the Argentine Republic. Nature **40**:223.—Letter from a botanist, Carlo Spegazzini, asserting two finds of hibernating swallows probably of the genus *Progne*.

132. SCOTT, W. L. 1884—The winter Passeres and Picariae of Ottawa. Auk **1**(2): 156-161.—Live swift coming out of a chimney in February (p. 161).

133. SHARPE, H. BOWDLER, AND C. W. WYATT 1885-1894—A monograph of the Hirundinidae or family of swallows.—In Vol. 1, pp. lix-lxx is quoted matter (from Coues and Salvadori) but nothing original on the supposed hibernation of swallows.

134. SMITH, COLIN 1827—Facts in regard to the hybernation of the chimney swallow (Hirundo rustica). Edinburgh New Philosophical Jour. **3**:231-234.—Hearsay; five birds torpid about 6 weeks after normal date of departure recovered in a heated room and flew away.

135. STROTHER, W. A. 1881—The sora. American Field **16**(18):276.—Second-hand report of thousands in Chickahominy Swamp, Va., in midwinter.

136. [SUCKLEY, GEORGE] 1860—In Suckley, George and J. G. Cooper. The natural history of Washington Territory and Oregon, etc. New York.—Some maintain that the blue grouse passes the winter in evergreen trees in a state of semi-torpor of which he has little doubt. However, James Beer, a close student of this species writes me (Jan. 31, 1944) that he has found the birds active throughout the winter (p. 20).

137. [SUNDEVALL, C. J.] 1850—Svalornas hibernation. Öfv. Kgl. Svenska Vet-akad. Förhandlingar, **1849-50**:181-185.—Statement from an eye-witness and suggestion that a real phenomenon must be basic to the numerous reports and that scientists should find out what it is.

138. ———1851—Om svalans hibernation. Öfv. Kgl. Svenska Vet-akad. Förhandlingar, **1850-51**:7-11.—An affidavit and another report from eye-witnesses. Again urges investigation of the matter and gives notice of a reward offered by himself and colleagues of the Zoological Museum for specimens of hibernating swallows.

139. ———1854—Om svalans hibernation. Öfv. Kgl. Svenska Vet-akad. Förhandlingar, **1853-54**:135-140.—No claim of the reward has been made. Sundevall thinks that many of the reports of swallows plunging beneath the water arose from observations on water ouzels. Those would not account for the alleged finds of masses of swallows, however, and the question is not yet entirely solved.

140. SWAINSON, CHARLES 1886—The folk lore and provincial names of British birds. —Hibernation of swallows is referred to in quotations from Olaus Magnus and J. Swan, p. 51.

141. THOMPSON, ZADOCK 1842—History of Vermont, natural, civil, and statistical, etc. Burlington.—Refers to Williams' (q.v.) account of swallow trees (**1**:98).

142. THOMPSON, A. LANDSBOROUGH 1926—Problems of bird-migration.—Hibernation discussed, pp. 22-23, and dismissed "as lightly as those once popular notions that birds become transformed into other species in winter or that there is migration between the earth and the moon."

143. THOMPSON, J. ARTHUR, AND PATRICK GEDDES 1931—Life: Outlines of general biology.—"We are not aware of any *á priori* reason why birds should not hibernate." (**1**:60).

144. TODD, ROBERT B. 1839—The cyclopaedia of anatomy and physiology.—"It has been said that the swallow belongs to the hibernating class, but this is incorrect." **2**(764-776.)

145. WALTON, IZAAK, AND CHARLES COTTON (no date)—Complete angler (Reprint of the Fifth Edition 1676). New York and Boston.It is well known that swallows and wagtails "sleep out the whole winter" in hollow trees or clay caves.

146. WATSON, E. L. GRANT 1936—Enigmas of natural history. London.—"Long-tailed tits have been known to hibernate," (p. 95).

147. WHITE, GILBERT 1907—Natural history of Selborne & observations on nature. New York.—White records reports of friends that swifts and swallows had been found torpid in dry places. (Pt. **1**:33-34) and apparently he himself believed that they could become dormant (Pt. **1**:35-38, 50, 92, 175-178, 205; Pt. **2**:2, 8, 83), though his searches for them were fruitless.

148. WILLIAMS, SAMUEL 1794—The natural and civil history of Vermont. Walpole, N. H.—Among other matter on bird hibernation is an eye-witness (his own) account of a swallow that was dug up in a salt marsh in February and revived. (pp. 115-116.)

In "the Second Edition, corrected and much enlarged," Burlington, Vt., 1809, is second-hand testimony as to the house swallow (chimney swift) hibernating in a hollow tree. (p. 143.)

149. WILLIAMSON, WM. D. 1832—The history of the State of Maine from its first discovery, A.D. 1602, to the separation, A.D. 1820, inclusive. Hallowell.—Assertion of swallow hibernation; no evidence.

150. WILSON, ALEXANDER 1804-14—American Ornithology, or the natural history of the birds of the United States. Philadelphia.—Describes brief torpidity in a ruby-throated hummingbird (**2**:30-31); grants temporary torpidity of chilled

bank swallows and chimney swifts but rejects subaqueous or other hibernation of swallows (**5**:35-37, 50-52), and of the sora (**6**:28).
a day recovered (**2**:210-211).

151. ———, AND C. L. BONAPARTE 1831—American Ornithology: or the natural history of the birds of the United States. Edinburgh.—Hummingbird torpid half

152. WILY, THOS. 1870(?)—Swallow lore. Trans. Nat. Hist. Soc. of Ottawa Paper III:35-55.—Read before the Society, Dec. 10, 1869. Quotes old accounts of swallow hibernation, which he rejects. Notes chimney swifts remaining at the roost without food for 2-3 days.

152. WILY, THOS. 1870(?)—Swallow lore. Trans. Nat. Hist. Soc. of Ottawa, Paper Amer. Jour. Sci. & Arts **24**:363-369.—Refers to Lea's article (1825) and considers its statements "as inconclusive, especially as relative to the higher latitudes."

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U. S. FISH AND WILDLIFE SERVICE
CHICAGO, ILLINOIS.

Luminosity in Birds

W. L. McAtee

The story of luminous birds, in the material available to me, begins with the Natural History of Pliny, A.D. 77. The bird concerned is not the *Avis incendiaria,* as might well be supposed, but a more briefly mentioned kind that is given no specific appellation. In the Bostock and Riley translation (1855), Pliny is quoted as saying: "In the Hercynian Forest, in Germany, we hear of a singular kind of bird, the feathers of which shine at night like fire" (p. 528). An identification of this bird, which has been referred to by other authors, was made by Bartholin in 1669. His account, mentioning authorities, all traceable to Pliny, may be rendered as follows: "Pliny reported a Hercynian bird, the plumage of which gives a light like fire at night. Clarius Solinus in his Polyhistory (Chapter 20) relates that there are birds in the Hercynian Forest, the feathers of which shine and glitter through the darkest night, where many men on nocturnal excursions found the birds an aid in guiding them and moderating the difficulties of the obscure trails by their refulgent feathers. There the Garrulus bohemicus, described by Gesner is seen, of which the tip of the tail and the ends of the wing bear shining beads that faintly glimmer by night" (p. 292).

Besides these "sealing-wax" beads of the waxwing, red and yellow eyes and iridescent plumage have given rise to reports of luminosity in birds, perhaps as much by confusion of terms as by intent. However, Chisholm (1935) definitely claimed local luminosity for certain Australian birds as follows: "Some years ago a man climbed fifty feet to the nest of a Scaly-breasted Lorikeet, and when he gazed into the hollow he was startled to see two bright objects, apparently of a phosphorescent nature, that moved in the darkness and somewhat resembled eyes. Fearing a snake, he lit a magnesium wire and placed it in the hollow, with the result that the bright objects were proved to be the mouths of young Lorikeets. It has since been discovered that the young of certain other Australian birds which breed in hollows have luminous margins to the mouths. These 'candles' appear to act as a guide to the parents at feeding-times.

"A kindred oddity occurs with the nestlings of some Finches. The inside of the mouth is white or flesh-pink, and the palate is marked, in the fashion of a domino, with black spots. At the back of the gape are three prominent rounded tubercles in the form of a triangle. In one instance two of these spots were emerald-green and one blue, and all had an opalescent lustre" (p. 268). These "light organs" of nestling birds were investigated by Brandes (1902), Butler (1898), Chun (1903), Marshall et al. (1913), and Rey (1901) and the consensus is that they reflect, but do not produce light. Nev-

ertheless, there is credible testimony as to luminescence among birds and most of it came in two surges: one relating to the barn owl in Europe and the other to herons, especially the night heron in America.

J. H. Gurney, an English ornithologist of some eminence, in writing (1908b) of luminous barn owls being "an attested reality," cited the experience of several observers in Norfolk. According to J. A. Harvie-Brown such birds had been seen as early as 1866, and local names for them indicated rather wide popular observation of their luminosity. Such appellations are: "glim ullert" (shining owl, Shropshire) and glimmer gowk (Dobbs 1911) and lantern bird, will-a-wix, and billy wix (Pigott 1908). Gurney (1908a) suggests that these phenomena may be explained by contact of birds, in tree cavities, with touchwood made luminous by fungus mycelia. These English accounts stimulated discussion, especially in the *Revue Française d'Ornithologie*. Here the literature was reviewed and additional observations concerning luminous birds (probably owls) in Spain, were recorded (Bouvier; Denise; Paris; Ternier (all) 1910). Bertoni (1919) referred to the barn owl as a luminous bird in Paraguay.

As to luminescence in North American birds, the earliest record I have seen was published in Loudon's *Magazine of Natural History*, 1829. It was an extract from a letter by Mrs. C. Hackney relating to the Great American Bittern. In part, she said: "it has the power of emitting a light from its breast, equal to the light of a common torch, which illuminates the water, so as to enable it to discover its prey. As this circumstance is not mentioned by any of the naturalists that I have ever read, I had a difficulty in believing the fact, and took some trouble to ascertain the truth, which has been confirmed to me by several gentlemen of undoubted veracity, and especially by Mr. Franklin Peale, the proprietor of the Philadelphia Museum" (p. 64). In 1874, Westcott supported this asservation and doubtless referred to the American and least bitterns in saying that he experimented with the powder-down of the birds "in a dark room and found it of the same nature as 'fox fire.'" The periodical for which he wrote, namely *Forest and Stream*, engaged in considerable discussion of luminous herons and contained an eye-witness account of the phenomenon in the night heron (Wyman 1874). In this magazine the well-known ornithologist, C. J. Maynard (1870) says, "As substantiating the hypothesis concerning the luminousness of the peculiar spot on the breast of this Heron, I give the following, as related to me by Mrs. H. B. Farley, of Ipswich. I may state that Mrs. Farley [Maynard's sister], until after she had related the story, had no knowledge of any particular interest being attached to the fact she had discovered; for this reason she was an unbiased observer, which gives the discovery additional importance. 'Three or four years ago I was sitting on the banks of Ipswich River, just at twilight, waiting for my brother to come for me in a boat to convey me home. I was keeping very quiet, when I saw a Heron alight within a few feet of me, on the edge of the water. He was joined by others, until there were about a dozen, then I observed that every one of them had a luminous spot on its

breast. This spot was not very bright, but, as it was quite dark by this time, *plainly perceptible.* They presented a peculiar appearance as they walked about, and I watched them with interest for some time. This singular light surprised me much, as I had never heard of anything like it before.' " (pp. 144-145). The great blue heron was implicated by hearsay (Williamson 1832) and by an eye-witness, J. P. Giraud, Jr., author of "The Birds of Long Island" (1844), who stated that the powder down of dead specimens "gives out a pale glow, not unlike that produced by decayed timber, familiarly termed 'light wood,' or 'fox fire' " (p. 278). A first-hand account of luminosity in this species both in life and in the cadaver was published by Isaac Worrall in the *Scientific American,* 1887. This was followed by comment by C. F. Holder (1887) who wrote, "Mr. Charles Harris, an ornithologist of Pasadena, tells me that in entering a heronry at night, in Maine, he noticed a number of lights there, which disappeared with the birds." In a book entitled "Living Lights" (1887, pp. 109-110), Holder recorded the answers to a series of question he had asked Worrall and from these it appears that the latter also observed luminescence in the night heron.

Minakata (1915) refers to old Japanese writings testifying as to luminosity in the night heron and the Eurasian gray heron.

Summarizing the above material and also that in the Annotated References, it appears that numerous persons have observed luminous barn owls and several have seen luminosity in herons. The testimony is of equal credibility to that supporting many items of accepted knowledge, and I accept it. I am especially disposed to do so in response to a manuscript note of Gurdon Trumbull, a meticulous observer and recorder, which reads, "I had better tell how I killed two [night herons] at Lyme and also of seeing the luminous light work when near the old mill that night with Annie." [Both his wife and a sister were named Annie; the latter, Annie Trumbull Slosson, was a patron of science as well as a scientist in her own right.] Testimony from an individual in whom one has complete confidence serves to "leaven a loaf" of less intimate material. Neither can the word of J. P. Giraud, Jr., nor that of C. J. Maynard's sister be disregarded. On the other hand, several ornithologists (Coues 1874, Forbush 1925, Gross 1923, Wetmore 1920, McAtee, unpublished) have sought in vain to see the "heron's light." At my request, Malcolm Davis of the National Zoological Park, Washington, D. C., observed both captive and free night herons for luminosity but without positive results. E. R. Kalmbach, on my suggestion, examined the powder down tracts of night herons in the field and also in a dark closet, but found no light. He sent me specimens of the tracts, which I tested for luciferin and luciferase, with negative results. However as Forbush (1925) says. reputable eye-witnesses "who have reported the light saw something," and scientists should continue to investigate the basis of these interesting reports. It appears probable that birds are sometimes luminous but probably not intrinsically so. The adventitious presence of light-giving fungi or bacteria has been suggested as a possible explanation of the reported phenomena.

ANNOTATED REFERENCES

1. ANDREWS, [JOSEPH] 1827—Journey from Buenos Ayres through the Provinces of Cordova, Tucuman, and Salta to Potosi, etc. London.—Eye-witness account of a luminous object reported by natives to be a bird, the *paca blanca* (**1**:132-136.)

2. ANONYMOUS 1873—The herons. Forest & Stream **1**:105.—All herons are provided with a natural lantern.

3. ANONYMOUS 1913—Luminous birds. Literary Digest **47**(15):627-628.—Based on an article in Knowledge (London, Sept. 1913), one item of which attributes the light to luminous bacteria attached to the feathers. The Digest accepts this as the probable cause of instances of luminosity observed among domestic pigeons.

4. BARTHOLIN, THOMAS 1669—De Luce hominum et brutorum. Libri III, Hafniae, De Avibus lucentibus: 291-301.—References to Pliny, Solinus, and Gesner on the Hercynian bird, i.e. *Garrulus bohemicus*, the waxy beads of which "faintly glimmer by night." (p. 292.)

5. BEARDSLEE, L. A. [PISECO] 1874—The herons and their lanterns. Forest & Stream **2**(4):54.—Report of an observation by a sailor on a Chinese heron; request for information.

6. BERTONI, A. DE W. 1919—Apuntes sobre aves del Paraguay. El Hornero **1**(4): 284-285.—Night heron and barn owl reported as luminous; speculation as to cause.

7. BOSTOCK, JOHN, AND H. T. RILEY (translators) 1855-1857—The natural history of Pliny. London.—Accounts of the "Avis incendiaria" (**2**:492-3), not, however, a luminous bird; and of the shining bird of the Hercynian Forest (**2**:528).

8. BOULENGER, E. G. 1927—Animal mysteries. London.—In fish-eating birds "the mysterious light is entirely due to the phosphorus emanating from the putrefying offal which has become stuck to the plumage."

9. BOUVIER, AMÉDÉE 1910—Sur les oiseaux et les oeufs luimneux anciennement signalés. Rev. Française d'Ornithologie 1, Ann. **2**(14):220.—Remarks of Pliny and Belon noted; and references given to a description of luminous hen's eggs.

10. BRANDES, G. 1902—Über leuchtorgane am vogelschnabel. Zeitschr. f. naturwiss. (Naturw. Verein f. Sachsen u. Thüringen) **74**(5-6):458-460.—Report on nestling of *Phoephila mirabilis* sent him by a correspondent who thought the tubercles in the gape produce light. Microscopical examination revealed no cells similar to those of luminescent structures in other animals.

11. BREHM 1831—Eine naturgeschichtliche Anfrage. Isis **3**:274.—Reference to light of the great American heron (i.e. bittern); doubtless a repercussion of the Hackney article.

12. BUFFON, G. L. L. 1777—Histoire naturelle des oiseaux. Paris.—The titles Microphenix, Avis incendiaria, and Avis incineraria are referred to *Bombycilla garrula* because its irides and the waxy tips of its feathers are of the color of fire (**4**: 142).

13. BUTLER, ARTHUR G. 1898—On the ornamentation of the mouth in the young Gouldian finch. Avicultural Mag. **5**:25-27.—The tubercles at the sides of the gape (figured and described) are iridescent due to fine reticulation of the outer surface.

14. CHISHOLM, ALEXANDER H. 1935—Bird wonders of Australia.—The nestlings of the scaly-breasted lorikeet and certain finches have luminous margins or spots in the linings of their mouths. (**2**:268.)

15. CHUN, CARL 1903—Über die sogenannten Leuchtorgane australischer Prachtfinken. Zool. Anzeiger **27**(2):61-64.—Reflects light but is not phosphorescent.

16. COUES, ELLIOTT 1874—Powder-down. Forest & Stream **2**(9):134.—All herons have powderdown tracts; nothing is known of their function; he has never observed luminosity.

17. DENISE, LOUIS 1910—Les oiseaux lumineux et de livre "De Luce Animalium" de Thomas Bartholin (1647). Rev. Française d'Ornithologie **1**, Ann. **2**(17-18): 283-284.—References to Pliny, Solinus, Gesner, and especially Bartholin, a Dane, who in 1647 published a book that contained a chapter on luminous birds. The Plinian birds of the Hercynian Forest are identified as Bohemian waxwings. Many references to luminosity deal rather with iridescence. Bartholin records a rather general occurrence of phosphorescence on meats, etc., at Montpelier, France, in 1641; luminous fowls were noted at that time.

18. DOBBS, MILDRED E. 1911—Luminous owls. Irish Naturalist **20**:124-126.—Observations on moving lights assumed to be owls. Interpretative comment by C. B. Moffat (pp. 127-131) and by Pastor C. Lindner (pp. 177-178).

19. EHRENBERG, [C. G.] 1836—Das Leuchten des Meeres. Neue Beobachtungen nebst übersicht der Hauptmomente der geschichtlichen Entwicklung dieses merkwürdigen Phänomens. Abh. Kgl. preuss. Akad. Wiss. Berlin. **1834**:411-575.—Thoroughly abstracts and indexes the literature of the entire subject of organic manifestations of light. Refers to the Brehm note, Herrera's luminous American birds (same as by Sumichrast, q.v.), and those of the Harz by Pliny; classes all as uncertain.

20. FORBUSH, E. H. 1925—[Night heron.] Birds of Massachusetts and other New England States **1**:338.—Has talked with two reputable eye-witnesses and received letters from three others, but ornithologists, including himself, have not been successful in seeing the light.

21. GIRAUD, J. P. JR. 1844—The birds of Long Island. New York.—Blue heron reported to have a lantern and the author has noted a glow from the powder-down patches of dead specimens (p. 278).

22. GROSS, ALFRED O. 1923—The black-crowned night heron (Nycticorax nycticorax naevius) of Sandy Neck [Part 2]. Auk **40**(2):191-214.—"I am inclined to believe that the phosphorescence is a product of the imagination." (p. 205.)

23. GURNEY, J. H. 1908a—Ornithological report for Norfolk (1907). Zoologist 4th Ser. **12**:121-122.—Eye-witness reports of luminous barn owls; the luminosity probably due to a fungus growing in the tree cavities frequented by the birds.

24. ———1908b—The luminous owl. Zoologist 4th Ser. **12**:134-135.—Barn owl; reports from several eye-witnesses.

25. HACKNEY, C. 1829—The great American bittern. Loudon's Mag. Nat. Hist. and Jour. Zool. etc. **2**:64.—Has the power of emitting a light from its breast, a circumstance confirmed to me by several gentlemen, especially Franklin Peale. Extract of a letter from Philadelphia.

26. HAMMOND, S. W. 1873—What becomes of the fish? Forest & Stream **1**:75.—Night heron carries its own light on its breast.

27. HARTING, JAMES E. 1906—Recreations of a naturalist. London.—Quotes Holder on alleged light of herons and favors the belief.

28. HARVEY, E. NEWTON 1940—Living light.—Refers briefly to instances of alleged avian luminosity (p. 17); and summarizes: "Fish are the highest group of animals

in which self-luminosity is known. All the reported cases of light from amphibia, reptiles, birds and mammals have been due to some secondary phenomenon" (p. 87).

29. HOLDER, C. F. 1881—Living lanterns. St. Nicholas **8**(12):910-912.—Reports that there is widespread belief along the Florida coast that the light is an aid to herons in attracting fishes.

30. ———1887—Phosphorescent cranes. Scientific American **56**(13):197.—Refers to his own book (1881), q.v.; Worrall's testimony, q.v.; and to that of Charles Harris who told Holder that he had seen lights in a Maine heronry that disappeared with the birds.

31. ———1887—Living lights. A popular account of phosphorescent animals and vegetables. New York.—Chapter 14 (pp. 109-115) deals with luminous birds; quotes three eye-witnesses of luminosity in the night heron and great blue heron.

32. KERVILLE, HENRI GADEAU DE 1893—Die Leuchtende Tiere und Pflanzen. Aus dem Französischen übersetz von W. Marshall. Leipzig.—The possibility of luminosity has been mentioned for the night heron and the blue heron (p. 134). Reference to light-giving Lampyridae being incorporated into the nests of a weaverbird (*Ploceus baya*). This matter is presented also in Marshall's "Die Tiere der Erde," (**2**:272-273).

33. KILLERMAN 1905—Leuchtende Vogelnester und Vögel. Naturwiss. Wochenschrift **20**(25):392-395.—Luminosity of nests may result from incorporation in them of phosphorescent plant materials, especially fungi. Review of cognate literature.

34. LESSON, R. P. 1831—Traité d'Ornithologie ou Tableau methodique . . . d'Oiseaux. Paris.—Reference to the Hackney report on the great American bittern (pp. 570-571).

35. LOCKWOOD, SAMUEL 1878—The night herons, and their exodus. Amer. Nat. **12**(1): 27-35.—Hearsay as to luminous legs (p. 32).

36. MARSHALL, WM., ET AL. 1913—Die Vogel von Alfred Brehm. Leipzig.—The "Leuchttuberkeln" of *Poëphila gouldiae* are discussed and Chun's conclusions accepted (**4**:452); the bodies are well illustrated in a plate facing p. 375.

37. MAYNARD, C. J. 1870—The naturalist's guide. Boston.—Quotes an eye-witness to luminosity in the night heron (pp. 144-145). This observation cited by R. L. N. in Forest & Stream **2**(10):150.

38. MCILWRAITH, THOMAS 1861—Luminous feathers on the breast of the Canadian blue heron. Zoologist **19**:7758.—Fishermen aver that the powder downs "emit a phosphorescent light," supposed to be attractive to fishes. Quoted from the Canadian Naturalist, but indexes for the volumes 1856-61 did not note the article.

39. MINAKATA, KUMAGUSU 1915—Phosphorescent birds. Notes and Queries (London) Ser. II, **12**(299):213-215.—Myths about them in Japan; evidence of actual occurrence; some of it may be due to reflected moonlight.

40. PARIS, PAUL 1910—A propos des oiseaux lumineux. Rev. Française d'Ornithologie 1, Ann. **2**(14):216-217.—References to three American accounts, all cited in the present bibliography. Plumicolous fungus the most attractive of proposed causes.

41. PIGOTT, T. DIGBY 1908—Luminous owls and the "Will o' the wisp." Contemporary Review **94**:64-72.—Review of literature, with supplementary remarks; he is confident of the genuineness of some of the phenomena.

42. PRINCE, EDWARD E. 1897—The pelican. Ottawa Naturalist **13**:97-101.—White pelican; "the breast feathers [powder-downs] are often said to be phosphores-

cent, and when the pelican is fishing at night they are declared to lure the fish" (p. 101).

43. PURDY, R. J. W. 1908—The occasional luminosity of the white owl (*Strix flammea*). Trans. Norfolk and Norwich Naturalists' Soc. **8**(4):547-552.—Seen at intervals from February 3, 1907, to January 16, 1908, by numerous persons, who, with the instances are catalogued.

44. REY, EUGEN 1901—Rätselhafte organe bei Vögeln. Ornith. Monatsber. **9**(7):97-98.—Porcelain-like warts at the angles of the mouth of nestling finches. It is uncertain whether they are light organs or merely reflectors.

45. SIBOUR, L. DE 1913—The existence of luminous birds. Knowledge, N. S. **10**(9): 321-322.—Review of literature, nothing original.

46. SUMICHRAST, F. 1869—The geographical distribution of the native birds of the Department of Vera Cruz, with a list of migratory species. Mem. Boston Soc. Nat. Hist. **1**(16):542-563.—Eyes of *Junco cinereus* (= *phaeonotus*) popularly believed to be phosphorescent (p. 551). Original account in La Naturaleza, **1**(15-16):312.

47. TERNIER, LOUIS 1910—Les oiseaux lumineux. Rev. Française d'Ornitholiogie 1, Ann. **2**(7):180-183.—Review of published accounts of Elorza (Spain) and Gurney, et al. (England).

48. ———1910—A propos des oiseaux lumineux. Rev. Française d'Ornithologie 1, Ann. **2**(14):217-219.—Further discussion of the findings of Elorza in Spain and Gurney in England; owls involved in both countries.

49. WESTCOTT, CHAS. S. 1874—The luminous breast of the night waders. Forest & Stream **2**(7): 103.—The powder down tracts of the lesser bittern are luminous in nature and in a dark room; eye-witness account.

50. WETMORE, ALEXANDER 1920—The function of powder downs in herons. Condor **22**(5):168-170.—In numerous trials "was unable to observe that these tracts were luminous."

51. WILLIAMSON, WM. D. 1832—The history of the State of Maine from its first discovery, A.D. 1602, to the Separation, A.D. 1820, inclusive. Hallowell.—Hearsay that powder downs of the blue heron are luminous (**1**:145).

52. WORRALL, ISAAC N. 1887—Phosphorescent birds. Scientific American **56**(9):133. --Eye-witness account relating to great blue heron, one of which was shot, and showed the phosphoric spots after death.

53. WYMAN, L. 1874—The "heron's torch." Forest & Stream **2**:103.—The night heron has the "torch"; "I have been conversant with . . . this fact from my earliest boyhood" and have noted the light in Massachusetts, New York, Canada, and elsewhere.

INDEX TO BIRDS ACCORDING TO REFERENCE NUMBERS

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U. S. FISH AND WILDLIFE SERVICE
CHICAGO, ILLINOIS.

Distribution of Seeds by Birds

W. L. McAtee

The ways by which seeds may be distributed by birds, though susceptible to considerable subdivision, are essentially three, namely, by external adhesion, through alimentation, and in transport for storage. Birds are not as often involved in the distribution of burs as are the hairy-coated mammals but they infrequently have been noted in this role. Dissemination by simple adherence is far more common as in the case of waterfowl which rise with floating seeds attached to their feathers and carry them varying distances, frequently to favorable environments. The birds chiefly involved in this regard are the gallinules, coots, ducks, and geese. Some remarkable instances have been noted of the transport of seeds in mud which had become stuck to the feet and legs of shore birds. These cases, however, are exceptional. Characteristically these parts of birds, even of the waders, upon examination in the field prove very clean.

When seeds are eaten for nourishment they are usually digested. Weed-seed eaters doubtless maintain a more than favorable balance between control and spread of their often noxious food species, although abnormally they may scatter viable seeds of such plants. The most notable weed-seed eaters include the doves, quails, pheasants, other upland game birds, horned larks, blackbirds, and especially the numerous members of the sparrow group.

When seeds are taken as part of a fruit, particularly a fleshy one, the surrounding pulp is digested and the pits in most instances are either regurgitated or voided in an entirely viable condition and often improved for germination. Aside from dissemination by living birds, this method leads to the sprouting of plants from the bodies of dead birds and also to secondary distribution through scattering of intenstinal contents of seed-eaters devoured by hawks, owls, or other predators. The more prominent fruit-eating birds include the thrushes, robins, bluebirds, thrashers, catbird, mockingbirds, waxwing, phainopepla, and crows. Occasionally frugivorous birds as woodpeckers, certain flycatchers, swallows, vireos, and warblers also take part in the scattering of the seeds of fleshy fruits.

Transport for storage usually of acorns, nuts, or other large seeds, results in some of them being dropped unheeded, and others being stored and not used, either through surfeit, forgetfulness, or death of the hoarder. Jays and woodpeckers are notable in this phase of seed distribution but crows, titmice, and nuthatches also participate.

The crow attains importance with regard to seed distribution because of its population density, vast range, migratory and local movements, frugivorousness, pellet formation, and habit of associating in roosts some of which are enormous. When grain is lacking, the crow may take wild fruit to the extent

of one-half of its diet. It assimilates the pulp but rejects the seeds mainly in regurgitated pellets. At the roosts, which may accommodate as many as 200,000 birds, these pellets and excreta cover the ground. Near Washington, D. C., Barrows (1889) reported a pound of this material to 4 square feet beneath a roost (Arlington) covering about 15 acres. The total quantity of material was estimated at some 80 tons. Analysis of a single pound yielded 4,764 seeds of wild fruits. Nearly 30 percent of these were of poison sumac. As far as the seeds of these noxious plants being deposited at the roosts is concerned, there is some compensation because most of them cannot possibly gain a foothold and fail to survive. At the roosts, however, plants from such seeds dominate. At the Woodridge roost, probable successor to that at Arlington, and also near Washington, I found 51 small plants of poison sumac (and one of a bramble) on a single square yard of ground. Not all of the pellets of the crow are regurgitated at the roosts. Many are ejected at random and thus facilitate wide distribution of the contained seeds. Because of its capacity for food, fondness for wild fruits, ejection of seeds in a viable condition, and its systematic movements, the crow is certainly the most important distributor of the plants whose seeds are included in its diet.

The red-cedar, a conifer, has its cones modified into fleshy berries. These are produced in great abundance and apparently are very attractive to most fruit-eating birds. Prominent among some fifty avian species consuming these fruits are the common crow, the cedar waxwing or cedarbird (named for this fondness), robin, bluebird, and starling. The seeds are ejected undamaged by most of these birds and are distributed far and wide. Birds are credited under varying conditions with from 60 to 100 percent of the total dissemination of this tree (Phillips 1910). It is often said that fencerows of redcedars so characteristic of the main range of the species, were planted by birds. This is doubtless true though most of the seeds are dropped at random. Cultivation and perhaps to some extent grazing have restricted these plants to the fencerows since they spring up everywhere in abandoned fields. One of the consequences of the seeds being dropped from perches is the establishment of colonies of red-cedars (along with other fleshy fruited species) under trees. There the shade-tolerant cedars with compact sharp-topped growth rise above the trees they are able to excel in height and by a combination of top-smothering and root-competition eventually kill them. This process probably causes no economic loss since the wood of red-cedar is highly valued. The destruction of fruit trees by this method might seem more serious but this results only when neglect is so pronounced that the orchards are apparently considered of no further value. The red-cedar is also deleterious to apple trees since it serves as a host plant for apple rust. It thus constitutes a menace to commercial apple orchards as do the birds which disseminate its seeds.

Economically, dissemination of plant species by birds has varying significance. Birds which rarely distribute burs render man a slight disservice while those which transport adhering seeds (and even entire plants as the duckweeds), on the whole benefit him through serving as the principal agents

operative in extending the range of marsh and water plants. Seed distribution by the hoarding species of birds is credited as an important factor in forestation. Fruit-eating birds also play an important part in forest planting and serve as the principal means of dispersion for many kinds of shrubs, vines, brambles, and a few herbs such as pokeberry, strawberry and their allies. In volved also is the scattering of the seeds of the poison sumac which is by no means a blessing to man. Damage to man's interests also is caused by the dissemination of plants that are hosts to fungi which affect commercially valuable species.

Which way the balance tends, in regard to bird as a group, is difficult to determine. It is perhaps best to consider individual avian species and particular instances of seed distribution before deciding upon destructive action. We should bear in mind the general value of the forms concerned and remember that while we can eliminate, we can not replace, birds whose presence and services would be greatly appreciated at another time.

ANNOTATED REFERENCES*

1. ADAMS, CHARLES C. 1923—Notes on the relation of birds to Adirondack forest vegetation. Roosevelt Wild Life Bul. **1**(4):487-519.—"Reforestation by birds" (pp. 493-496) gives evidence of seed distribution by the robin and cedarbird. The scattering of seeds by birds is a valuable reforestation service.

2. ANONYMOUS 1938—Robins roost in Montgomery County. North Carolina Wildlife Conservation **2**(4):3-6.—Droppings contained dogwood and holly seeds.

3. BAILY, WM. L.—1897—Disgorgement of cherry stones again noted. Auk **14**:412-413.—Robin, wood thrush, and catbird disgorging cherry stones.

4. BARROWS, WALTER B. 1889—The food of crows. Ann Rept. U. S. Dept. Agr. **1888**:498-535.—"Distribution of noxious seeds" (pp. 508-510), especially those of poison sumacs; extent; germination tests reported.

5. ———1891—Seed-planting by birds. Ann Rept. U. S. Dept. Agr. **1890**:280-285.—"Seeds which simply contain nourishment are eaten and destroyed, while seeds which are contained in nourishment are eaten and survive." (p. 281); role of the crow abstracted from his 1889 paper; list of 7 birds that eat seeds of poison sumac; the greenish fruits of these plants are eaten more freely than the red fruits of the non-poisonous sumacs; notes on disgorgement of seeds.

6. ———1912—Michigan bird life. Mich. Agr. College Special Bul. **1912**:1-822.—Distribution of poison ivy seeds by the downy woodpecker (p. 349), woodpeckers (359), crow (426-427), Tennessee warbler (589), and myrtle warbler (604); shrub and tree seeds by the bluejay (414), crow (426), cedarbird (558); notes on the storing habit of the redheaded woodpecker (365).

7. BARROWS, WALTER B., AND E. A. SCHWARZ—1895—The common crow of the United States. U. S. Division of Ornithology and Mammalogy Bul. **6**:1-98.—Deposits at crow roosts include seeds of sumacs, flowering dogwood, sour gum,

* North American literature. Text-books entries are made only when there is something original in the treatment of seed distribution. The writer is indebted to Drs. Sidney F. Blake and William R. Van Dersal for checking a draft of this bibliography and to the former for suggesting additions and preparing an abstract of A. N. Prentiss' book.

and other wild fruits; regurgitated pellets and their seed contents are described; a pound of ejecta collected from an area 2 feet square under a crow roost contained 4,764 seeds of 6+ species (pp. 21-24).

8. BARTON, BENJAMIN S. 1812—Elements of botany, etc. Philadelphia, **2**:1-324.—"Birds in particular are very instrumental in this business" (i.e. dissemination, p. 260). Early records of seed dispersal by American birds (pp. 260-261).

9. BEAL, F. E. L. 1895—Preliminary report on the food of woodpeckers. U. S. Division of Ornithology and Mammalogy Bul. **7**:7-33.—Dissemination of poison ivy by the downy woodpecker (pp. 9, 13), hairy (16), yellow-shafted flicker (20), and red-bellied woodpecker (26).

10. ———1897—The blue jay and its food. Yearbook U. S. Dept. Agr. **1896**:197-206.—Brief reference to distribution of nuts and acorns (p. 204).

11. ———1906—Birds as conservators of the forest. Rept. New York Forest, Fish and Game Commission **1902-1903**:236-274.—Birds as distributors of seeds is the chief subject of pp. 265-272, wherein are discussed the roles in that respect of the woodpeckers, robin, cedarbird, jays, crow, pine grosbeak, and crossbills.

12. ———1907—Birds of California in relation to the fruit industry. Part I. U. S. Biological Survey Bul. **30**:1-100.—The western mockingbird (p. 53), California thrasher (56), plain tit (70), wren-tit (73), ruby-crowned kinglet (83), and hermit thrush scatter seeds of poison oak, "a weed of the worst description" (93).

13. ———1910—Birds of California in relation to the fruit industry. Part II. U. S. Biological Survey Bul. **34**:1-96.—Seeds of poison oak distributed by Nuttall's woodpecker (p. 21), red-shafted flicker (27); the California jay is an oak planter; all jays aid in planting forest trees (55).

14. ———1911—Food of the woodpeckers of the United States. U. S. Biological Survey Bul. **37**:1-64.—The seeds of poisonous sumac are scattered by the hairy (p. 16), downy (21), and Nuttall's woodpeckers, yellow-bellied sapsucker (30), yellow-shafted (58) and red-shafted (62) flickers; the red cockaded woodpecker no doubt "aids in distributing the seeds of the pines upon which it feeds" (23).

15. ———1915—Food of the robins and bluebirds of the United States. U. S. Dept. Agr. Bul. **171**:1-31.—The robin "is one of the most efficient disseminators of fruit seeds" (p. 13); seeds passed through the alimentary canal and those disgorged are differentiated; the former are reputed to "germinate more readily than those sown directly from the tree" (13).

16. ———1915—Food habits of the thrushes of the United States. U. S. Dept. Agr. Bul. **280**:1-23.—Mentioned as serving to distribute seeds of wild fruits are the wood thrush (p. 8), and of the poisonous sumacs, the hermit thrush (22).

17. BEAL, F. E. L., AND W. L. MCATEE 1912—Food of some well-known birds of forest, farm and garden. U. S. Dept. Agr. Farmers' Bul. **506**:1-35.—Audubon's warbler a disseminator of poison oak (*Rhus diversiloba*) (p. 33).

18. BEAL, W. J. 1898—Some unique examples of dispersion of seeds and fruits. American Naturalist **32**:859-866.—Brief reference to bird transport, that of bluejay and hazelnut most definite.

19. ———1898—Seed dispersal. Boston.—A number of definite instances of dissemination by birds are recorded: acorns and nuts (pp. 63-64); fleshy fruits (66-69); seeds in mud (71-72); burs (76).

20. BERGEN, JOSEPH Y. 1914—Introduction to botany. New York.—A brief but pithy section (p. 171).

21. BERGTOLD, W. H. 1917—Regurgitation in the Bohemian waxwing. Auk **34**:341-342.—Regurgitating seeds of Russian olives, accompanied by a clear fluid.

22. BESSEY, CHARLES E. 1905—Plant migration studies. University of Nebraska Studies **5**(1):1-27.—Trees and shrubs having fleshy fruits are distributed by birds (pp. 10-14).

23. BRAY, WM. L. 1910—The mistletoe pest in the southwest. U. S. Bureau of Plant Industry Bul. **166**:1-39.—*Phoradendron flavescens*. Seeds distributed in considerable numbers by birds, including mockingbirds, cedarbirds, robins (pp. 11-12).

24. CAMPBELL, JOHN T. 1886—Causes of forest rotation. American Naturalist **20**(6): 521-527.—Crows distribute acorns, beechnuts, walnuts, hickory-nuts, buckeyes, and sycamore balls (pp. 521-527).

25. CANNON, W. A. 1904—Observations on the germination of Phoradendron villosum and P. californicum. Bul. Torrey Bot. Club **31**:435-443.—Distribution from tree to tree probably always effected by birds (p. 436).

26. CHRYSLER, M. A. 1930—The origin and development of the vegetation of Sandy Hook. Bul. Torrey Botanical Club **57**:163-176.—Birds introduced seeds of most of the plants forming woodland and thicket.

27. COOPER, WILLIAM S. 1922—The ecological life history of certain species of Ribes and its application to the control of the white pine blister rust. Ecology **3**:7-16. —Records of *Ribes*-eating by birds, furnished by the Biological Survey, discussed in the light of ecological preferences of the birds. Those of open situations eat most of the *Ribes* fruits and as a class "are very effective as planters of *Ribes*." Other groups are of less importance.

28. COULTER, JOHN M., CHARLES R. BARNES, AND HENRY C. COWLES 1911— A textbook of botany for colleges and universities. New York **2**:485-964.—Dispersal by animals (pp. 923-925)). "The most useful animals from the standpoint of dispersal are such birds as the robins, thrushes, and blackbirds." The discussion is fuller than usual.

29. COWLES, R. B. 1936—The relation of birds to seed dispersal of the desert mistletoe. Madroño **3**:352-356.—Phainopepla and other birds distribute the seeds of *Phoradendron californianum*, many, however, to dead twigs where they perish.

30. CRIDDLE, NORMAN 1907—How the seeds of plants are spread in nature. Ottawa Naturalist **21**:27-31.—Spread by birds (p. 31) through their eating fleshy fruits and storing seeds.

31. DEWEY, LYSTER H. 1897—Migration of weeds. Yearbook U. S. Dept. Agr. **1896**: 263-286.—Note on distribution of fruit and weed seeds by birds; "it may be safely asserted that the benefits due to the destruction of weed seeds by seed-eating birds outweigh a thousandfold the damage arising from their distribution of the seeds." (p. 271).

32. EATON, ELON HOWARD 1914—Birds of New York. New York State Museum, Memoir 12, **1**:46-50.—Seed dispersal (pp. 46, 50).

33. FORBUSH, E. H. 1907—Useful birds and their protection. Massachusetts State Board of Agriculture, Boston. **1907**:1-437.—In a section entitled "Forest Planters," (pp. 92-96), the distribution of seeds by the wood thrush, bluejay, and crow is noted.

34. ———1921—The utility of birds. Massachusetts Dept. Agr. Bul. **9**:1-83.—General remarks on "Birds as distributors and planters of seeds" (p. 47). "Birds alone would soon replant all the cleared lands were it not for the mowing machine, the reaper and the tools of cultivation."

35. GRINNELL, JOSEPH 1897—Disgorgement among song birds. Auk **14**:318-319.—Robin, mockingbird, phainopepla, and cedarbird disgorging seeds of pepper-tree. Townsend's solitaire and varied thrush also seen disgorging, kind of seeds not stated.

36. ———1935—Why we need wild birds and mammals. Scientific Monthly **41**:553-556.—Up-hill planting of acorns by jays and band-tailed pigeons (pp. 554-555).

37. ———1936—Up-hill planters. Condor **38**:80-82.—California and Steller's jays, California woodpeckers, and band-tailed pigeons carrying acorns enable oaks to achieve uphill distribution.

38. HAMILTON, W. J., JR. 1940—Summer food of the robin determined by fecal analyses. Wilson Bul. **52**(3):179-182.—Seeds of 10 kinds of fleshy fruits reported; if entire, they would undoubtedly serve in dissemination.

39. ———1943—Spring food of the robin in central New York. Auk **60**:273.—Examination of feces showed distribution of barberry seeds.

40. HARVEY, BARTLE T. 1915—Notes on the dissemination of Virginia creeper seeds by English sparrows. Plant World **18**:217-219.—Seeds gathered from excrement beneath a roost gave a higher percentage of germination and produced stronger seedlings than others gathered directly from the plant. On fifty square feet of ground under the roost, 70 seedlings were found. Review in Auk **33**:342.

41. HAY, O. P. 1887—The red-headed woodpecker a hoarder. Auk **4**:193-196.—This species and the California woodpecker store acorns; the redhead stores also beechnuts, corn, and cherry seeds.

42. HENDERSON, JUNIUS 1927—The practical value of birds. New York.—Dissemination is treated on pp. 79-81, and more briefly elsewhere.

43. HILL, E. J. 1883—Means of plant dispersion. American Naturalist **17**:811-820, 1028-1034.—Role of birds in distributing the hard seeds of fleshy fruits (pp. 1030-1031).

44. JENNINGS, O. E. 1933—Some interrelations of plants and birds on Presque Isle, Erie, Pennsylvania. Proc. Penna Acad. Sci. **7**:192-195.—In an eastward migration of the plants (to correspond with a shift in the land), birds are regarded as playing a very important part. Small seeds of marsh plants probably get transported by sticking to the feet or feathers of birds, and seeds of fleshy fruits are dropped wherever there is vegetation large enough to provide perches (26 spp. are listed); acorns of pin oak by jays.

45. JUDD, SYLVESTER D. 1901—The relation of sparrows to agriculture. U. S. Biological Survey Bul. **15**:1-98.—Sparrows digest most of the seeds they eat but sometimes pass them in perfect condition for germination. The proportion of seeds thus evacuated must be insignificant (p. 22). An experiment with an English sparrow indicated that apparently all seeds eaten are digested (48-49).

46. ———1902—Birds of a Maryland farm. U. S. Biological Survey Bul. **17**:1-116.—Section on "distribution of seeds by birds" (pp. 62-65), especially mentions crow pellets and their contents and gives evidence of tree and shrub planting by birds not identified.

47. KALM, PETER 1937—Travels in North America. Translated by A. B. Benson **1**: 1-796.—Birds propagate the red-cedar (**1**:303); year of observation, 1749.

48. KALMBACH, E. R. 1918—The crow and its relation to man. U. S. Dept. Agr. Bul. **621**:1-92.—"Distribution of seeds" (pp. 68-71) discusses regurgitated pellets and their seed contents; quotes Barrows' data (1895); reports on seeds found at roosts in Missouri and the District of Columbia; 65 species of birds known to

feed on seeds of poisonous sumacs, many regurgitating them; extermination of the crow and other bird carriers would not control the spread of poison ivy.

49. ———1920—The crow in its relation to agriculture. U. S. Dept. Agr. Farmers' Bul. **1102**:1-20.—"Distribution of seeds" of wild fruits, including those of poison sumacs; the chances of sprouting of those deposited at the roost are poor (p. 13).

50. ———1927—The magpie in relation to agriculture. U. S. Dept. Agr. Technical Bul. **24**:1-29.—Disseminates wild fruits, including those of poison sumacs (p. 18).

51. ———1928—The European starling in the United States. U. S Dept. Agr. Farmers' Bul. **1571**:1-26.—Disseminator of poison ivy as are 66 species of native birds (p. 17).

52. ——— AND I. N. GABRIELSON 1921—Economic value of the starling in the United States. U. S. Dept. Agr. Bul. **868**:1-66.—Distribution of seeds of wild fruits, including those of poison ivy (pp. 36-37).

53. KEMPTON, F. E. 1921—Progress of barberry eradication. U. S. Dept. Agr. Circ. **188**:1-37.—Barberries, alternate hosts of wheat rust causing about a 10 percent loss of the crop, are disseminated locally by a number of birds that feed on the fruit.

54. KERN, FRANK D. 1921—Observations on the dissemination of the barberry. Ecology **2**:211-214.—References to European and American notes on birds feeding on the common barberry, and notes on a few field observations.

55. MCATEE, W. L. 1908—Food habits of the grosbeaks. U. S. Biological Survey Bul. **32**:1-92.—Mulberry and blackberry seeds from feces of cardinal nestlings (p. 24).

56. ———1916—Birds in relation to the dissemination of mistletoes in the United States. Auk **33**:446-447.—Review of several publications on the subject, list of mistletoe eaters, and suggestions as to control of the situation without killing birds.

57. ———1918—Curious hoarding habits of birds. Auk **35**:372-373.—Acorns put in large cocoons by bluejays.

58. ———1926—The relation of birds to woodlots in New York State. Roosevelt Wild Life Bul. **4**(1):7-152.—Distribution of tree and shrub seeds by birds (pp. 98-101, fig. 21).

59. ———1940—An experiment in songbird management. Auk **57**:333-348.—Seeds found in nests of robin, catbird, and starling show potentialities of fruit distribution (p. 336).

60. ———1944—Nurse killers. Nature Magazine **37**(3):146-147.—Red cedars distributed by birds, in some cases, grow up through nurse trees and kill them. Number and variety of bird-sown shrubs and trees under single chestnut and oak rampikes.

61. ———1944—Nurse killers. Journal of Forestry **42**(9):683.—Illustration of an apple tree being smothered by bird-sown red cedars.

62. MCNAIR, JAMES B. 1923—Rhus dermatitis, etc. Chicago.—Tabulation of 38 species of California birds known to eat fruits of *Rhus diversiloba;* comment on birds as distributing agents (pp. 42-43).

63. MACOUN, JOHN 1883—Notes on the distribution of northern, southern, and saline plants in Canada. Proc. and Trans. Roy. Soc. Canada, Ser. 1, **1**(iv):45-47.—

Discusses occurrence of maritime plants in the interior of the continent, and says, "I conclude . . . that, in every instance where a truly maritime species is found in the interior, the seeds were brought there by birds."

64. MARTIN, JOHN N. 1919—Botany for agricultural students. New York.—Bird dissemination, pp. 84-85; in addition to the ways ordinarily mentioned, birds also transport sprigs of plants bearing seeds.

65. MATHENY, WM. A. 1931—Seed dispersal. A student-made book. Ithaca.—"Bird distributors" (pp. 7:35) discusses seeds carried: in mud, by adherence to feathers, by mucilaginous attachment, as burs, in nest materials, when regurgitated or voided, when taken incidentally with other food, as stores, and through decay of the bodies of dead birds; includes original observation and experiment.

66. MELANDER, L. W. 1939—Battling the barberry. Minnesota Conservationist **67**:17-18.—The robin, catbird, cedar waxwing, and "blackbirds" scatter in viable condition the seeds of this host of stem-rust.

67. MUNSON, W. M. 1902—Distribution of plants in forest regions. Fourth Rep. Forest Commr. Maine **1902**:109-124.—Birds as disseminators of fleshy fruits (pp. 113, 116); seeds distributed in the bodies of birds that perish and by adhering to legs and feathers (117).

68. OSTENFELD, C. H. 1926—The flora of Greenland and its origin. Kgl. Danske Videnskabernes Selskab Biol. Meddelelser **6**(3):1-71.—Eleven species having fleshy fruits and three with burs probably transported from the North American mainland by birds.

69. PARISH, S. B. 1905—Birds and mistletoe: a correction. Torreya **5**:68-69.—Cedar waxwing and phainopepla feed on fruits and presumably distribute the seeds. "Passage through the stomach of the bird serves to remove the non-viscid epidermis, and leaves the sticky coating in condition for performing its office." References to two negative and one positive contributions to the literature.

70. PATON, ROBERT R., EDMUND SECREST, AND HAROLD A. EZRI 1944—Ohio forest plantings. Ohio Agr. Expt. Sta. Bul. **647**:1-77.—The role of birds in dissemination of trees and shrubs is stated in numbers and percentages; for an eastern Ohio plantation they held first rank among disseminating agencies.

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72. PLUMER, MARY N. 1882—Dissemination of seeds. Bul. Essex Inst. **13**:121-147.—"By birds" (pp. 138-142) mentions seeds of fleshy fruits, those that become attached to feathers, and nuts carried by jays.

73. PRENTISS, A. N. 1872—On the natural mode of the distribution of plants over the surface of the earth. Ithaca **1872**:1-19.—Discusses (pp. 10-11) various methods of distribution by birds: by depositing seeds of fleshy fruits eaten; by carrying seed uninjured in the crop and then being torn to pieces by a hawk, or dying for some other reason after flying a long distance; through attachment to feathers by means of barbs or awns, or by adherence to wet plumage; in mud on feet of wading birds. Nothing clearly original, except statement that common elderberry was seen growing well up on a broken and decayed tree trunk.—S. F. Blake.

74. PROCTOR, THOMAS 1897—Disgorgement among song birds. Auk **14**:412.—Cherry stones disgorged by nestling wood thrushes; apparently all thrushes share this ability; red-eyed vireo and myrtle warbler also observed to disgorge.

75. RITTER, WM. E. 1938—The California woodpecker and I. Berkeley.—California jay burying acorns (p. 35); the woodpecker storing acorns and other nuts and seeds [presumably distributes them to some extent or fails to use some of those stored that may fall to the ground and germinate].

76. ROESSLER, ELIZABETH S. 1936—Viability of weed seeds after ingestion by California linnets. Condor **38**:62-65.—These birds ordinarily digest seeds and therefore do not spread them "to any appreciable extent, if at all."

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78. SAYLE, MARY 1924—Viability of seeds passing through the alimentary canals of pigeons. Auk **41**:474-475.—Experimental results indicating that "voided seeds were crushed and digested" and these birds, therefore do not distribute seeds in their feces; some seeds, however, are regurgitated.

79. SETCHELL, WILLIAM A. 1926—Les migrations des oiseaux et la dissémination des plantes. Compt. rend. sommaire des Seances de la Soc. de Biogéographie No. **22**:54-56.—Inferential, especially, to explain discontinuous distribution; no definite evidence.

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81. SMALL, JOHN K. 1933-1935—Asiatic immigrants in the Botanical Garden. Jour. New York Bot. Gard. **34**:227-228, 276-277; **35**:155-156, 224-226; **36**:73-74. —Dissemination of several species by birds.

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83. STAKMAN, E. C. 1923—Destroy the common barberry. U. S. Dept. Agr. Farmers' Bul. **1058**:1-14.—Birds important in its dissemination (p. 8); *re* black stem rust of cereals.

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85. STEVENS, WILLIAM C. 1902—Introduction to botany. Boston.—"The birds are the most effective agents among animals for distributing seeds"; brief general discussion of their role. (p. 215).

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87. THOMPSON, NOEL F., AND W. W. ROBINS 1926—Methods of eradicating the common barberry (Berberis vulgaris L.). U. S. Dept. Agr. Bul. **1451**:1-45.—More than a dozen species of birds are known to eat the berries; birds one of the chief means of spread (pp. 3-4).

88. TURESSON, GÖTE 1918—Om långväga växttranport genom fåglar. [Distant transportation of plants by means of birds]. Botaniska Notiser **1918**:248.—As exam-

ples of plants transported long distances by birds are given *Carex festiva* and *Fragaria chilensis*, carried from Alaska to the Sandwich Islands. From P. A. Rydberg. Bot. Abstracts **4**(1):39.

89. WEBBER, HERBERT J. 1895—Studies on the dissemination and leaf reflexion of *Yucca aloifolia* and other species. Missouri Bot. Gard. Sixth Ann. Rep. **1895**: 91-112, Pls. 45-47.—The mockingbird is a very important factor in the dissemination of the species named; detailed observations (pp. 93-98, 111).

90. WEED, CLARENCE M. 1901—Seed-travellers. Boston.—Through floating seeds clinging to feathers, seeds in mud adhering to feet and legs (pp. 29-32), seeds of fleshy fruits being disgorged or voided (33-44), birds distribute plants.

91. WEIR, JAMES R. 1916—Larch mistletoe; some economic considerations of its injurious effects. U. S. Dept. Agr. Bul. **317**:1-25.—Birds are a minor factor in the spread (p. 24). *Razoumofskya laricis*.

92. ———1916—Mistletoe injury to conifers in the Northwest. U. S. Dept. Agr. Bul. **360**:1-39.—Grouse feed upon the plant, including its seeds, and birds may be a more important distributing agent than he formerly thought (p. 34). *Razoumofskya* spp.

93. WILSON, KENNETH A., AND ERNEST A. VAUGHN 1936—The Land Resettlement Administration and its wildlife program on the Eastern Shore of Maryland. Maryland Conservationist **13**(2):21-26.—Seeds of certain wild fruits and of herbs sometimes are passed whole; no report on their viability.

94. YORK, HARLAN H. 1909—The anatomy and some of the biological aspects of the "American mistletoe." Univ. of Texas Bul. **120**:1-31.—*Phoradendron flavescens* Pursh. "The seeds are distributed almost entirely as a result of being eaten by birds," among which mockingbirds, sparrows, and cardinals are mentioned (p. 7).

INDEX TO BIRDS ACCORDING TO REFERENCE NUMBERS

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U. S. FISH AND WILDLIFE SERVICE
CHICAGO, ILLINOIS.

Notes on the Natural History of the Bat, Myotis yumanensis, in California, with a Description of a New Race

Walter W. Dalquest

Introduction

Myotis yumanensis (H. Allen) is a species of bat that is common over much of the western United States and is especially widespread in California. In spite of this, relatively little is on record concerning its natural history, and some of the published information is misleading or erroneous. It has been the writer's good fortune to collect and observe a large number of bats of this species in the last three years. A planned life history study was not made, but the field notes accumulated in the course of other work offer a considerable amount of new information.

All specimens listed with regard to geographic variation are study skins in the collection of the Museum of Vertebrate Zoology, Berkeley, California. Skeletons and material preserved in alcohol were not used. Most of the natural history observations made in this work prior to May 3, 1945, were incidental to other mammal studies. Between May 3 and June 6, 1945, Miss Mary C. Ramage and Mrs. Peggy B. Dalquest accompanied the writer on several field trips. Much of the information concerning the habits of *Myotis yumanensis* was gained on these trips. The period between June 13 and June 30, 1945, was spent in the field by Dr. Seth B. Benson and the writer on a trip devoted almost entirely to collecting bats. Specimens of *Myotis yumanensis* were obtained from several localities in central and southern California and much was learned about the natural history of this bat. The persons mentioned above have allowed their notes to be used in this report and in some instances, data from specimen labels, or field notes on file in the Museum of Vertebrate Zoology, have been used to supplement personal observations.

The notes on the colony of bats at Wadsworth, Nevada, are included here because the locality is close to California and also because this is the only colony of the subspecies *M. y. yumanensis* which was examined personally. With this exception, the observations recorded were made in California. All specific localities mentioned in the text, unless otherwise stated, are in California.

Myotis yumanensis ranges from southern Mexico to British Columbia and over much of the western United States. Its range overlaps that of the closely related *Myotis lucifugus* in certain areas. *Myotis yumanensis* is a small bat of dull color. It may easily be distinguished from all other Californian bats save *Myotis lucifugus* by short ears (not extending past nose when laid forward), large feet (about 9 mm.), a straight and unkeeled

calcar, and a slim and straight tragus. Compared with *lucifugus*, *yumanensis* is usually smaller, duller in color, and cleaned skulls have a more steeply rising forehead. Some specimens are difficult to distinguish.

Variation and Distribution

Individual variation, especially in color, is often great in vespertilionid bats. Size and cranial proportions are also variable. Among the western species of the genus *Myotis*, *yumanensis* is relatively stable. In a series of 37 females from Oxalis, Fresno County, variation in the five standard measurements taken is as follows:

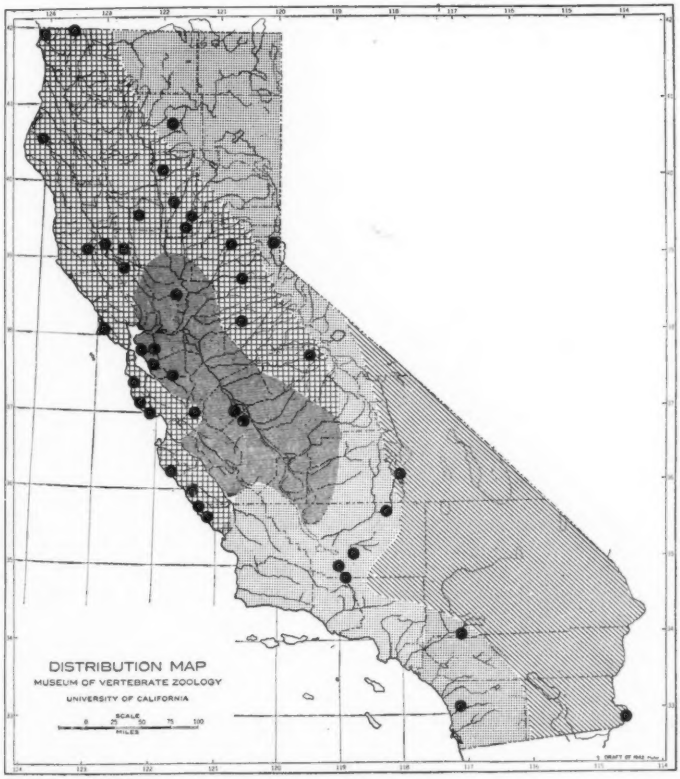

Fig. 1.—Distribution of *Myotis yumanensis* in California; the range of *M. y. yumanensis* is shown by diagonal lines, *sociabilis* by stippling, *oxalis* by horizontal lines, and *saturatus* by cross-hatching. Circles show localities from which specimens have been examined.

TOTAL LENGTH: Mean, 84; standard deviation, 2.1; mean deviation from mean, 1.8; range, 79-70.

LENGTH OF TAIL: Mean, 34.6, standard deviation, 1.3; mean deviation from mean, .76; range, 32-38.

FOOT: Mean, 9.5; standard deviation, .3; mean deviation from mean, .5; range, 9-11.

EAR: Mean, 13.9; standard deviation, .6; mean deviation from mean, .38; range, 13-15.

TRAGUS: Mean, 6.9; standard deviation, .2; mean deviation from mean, .5; range, 6-8.

Weights are influenced by pregnancy and stomach contents. Virtually all specimens in the larger series contained embryos. Specimens shot in the evening had full stomachs and weighed more than individuals taken in their daytime retreats. Twelve non-pregnant females (some of which were lactating), shot in the evening at the mouth of Limekiln Creek, Monterey County, weighed: mean, 6.3 grams; range, 5.6-7.2 (1.6 or 29 per cent); mean variation from mean, .47 grams.

Individual variation in color is usually not great. Some series are remarkably uniform. In most series, some individuals are paler or darker, redder or less red, than the average. Extremes may reach the mean color of other subspecies. One specimen from Castro Canyon, Monterey County, possesses a small white area on the neck.

Relatively little is known of age variation in *Myotis yumanensis*. The life-span in the species approximates five years, at least in some cases. An individual captured, banded and released at Berkeley, Alameda County, by Mr. Thane A. Riney previous to June 15, 1941, was recaptured at the same retreat by the writer on April 11, 1945. It was, presumably, at least one year old when banded. Thus minimum age at recapture was 4 years and 10 months. It was in good health and might have lived considerably longer.

Young bats are dark blackish-gray when first able to fly. The joints of the digits are thickened and are angular rather than knobby. Fully grown young of the previous year show completely adult characters. Males average lighter in weight than females. The mean weight of five males from Limekiln Creek, Monterey County, is 5.5 grams as opposed to 6.3 grams for non-pregnant females from the same locality. No significant difference was apparent in the standard measurements taken.

Geographic variation in color is great. Four subspecies based on color differences may be distinguished in California.

MYOTIS YUMANENSIS YUMANENSIS (H. Allen)

Type—From Old Fort Yuma, Colorado Desert, Imperial County, California (across the Colorado River from Yuma, Arizona).

Diagnosis—Color whitish, yellowish, or pale buff above; underparts white.

Range in California—The Colorado River Valley and the western edges of the interior deserts.

Specimens examined—Total, 2. IMPERIAL CO.: 6 mi. N Potholes, 1; INYO CO.: Carroll Creek, 5500 ft., 1.

Remarks—This race is represented from only two localities in California. It probably occurs only in the few places in the desert where both water and trees are present.

MYOTIS YUMANENSIS SOCIABILIS H. W. Grinnell

Type—From Old Fort Tejon, Tehachapi Mountains, Kern County, California.

Diagnosis—Color of upperparts olive or tan; pale whitish-buff beneath.

Range in California—The southern coastal area north through the Sierra Nevada to northeastern California in a narrow belt between the ranges of *saturatus* and *yumanensis*.

Specimens examined—Total, 134. *San Diego Co.*: Lake Hodges, near Escondido, 20; *San Bernardino Co.*: Redlands, 1300 ft., 1; *Kern Co.*: Lebec, 18, Old Fort Tejon, 60, 1 mi. NW Old Fort Tejon, 13, Tejon Ranch, 1300 ft., 8, Weldon, 2; *Placer Co.*: Tahoe City, 7, ½ mi. S Tahoe Tavern, Lake Tahoe, 1; *Shasta Co.*: Silver Lake, 4.

Remarks—In California this race seems to represent a condition intermediate between *yumanensis* and the darker forms to the west and north of its range. It has been assigned a wide range to the north and east of California and this range seems to be geographically continuous to the type locality.

Two specimens from Weldon, Kern County, are slightly paler than typical material, thus showing an approach to *yumanensis*. The latter race probably occurs to the east of Walker Pass, 20 miles away.

No specimens of either *yumanensis* or *sociabilis* are available from an extensive area south of Lake Tahoe, Placer County. Specimens from Lake Tahoe are like *sociabilis*, though a series from farther west in Placer County is referable to *saturatus* and a series from Wadsworth, Washoe County, Nevada, is closer to *yumanensis* than it is to *sociabilis*. Seemingly the range of *sociabilis* is very narrow in the area between the type locality and Lake Tahoe. To the north of Lake Tahoe it is probably much wider.

Specimens from south of Monterey Bay, in the immediate coastal area, show a gradual increase in paleness. A series from the Forks of Waddell Creek, Santa Cruz County, is clearly *saturatus*. A series from the mouth of Limekiln Creek, Monterey County, is intermediate between *sociabilis* and *saturatus* but closer to the latter. Two specimens from northern San Luis Obispo County are also closest to *saturatus*. It seems very likely that *sociabilis* occurs along the coast between San Luis Obispo and San Diego counties, though specimens from this area are not at hand. The San Bernardino Mountains are included in the range of *sociabilis* on the basis of a single specimen. Specimens from Lake Hodges, near Escondido, San Diego County, approach *yumanensis* in pale color but are best referred to *sociabilis*.

Myotis yumanensis oxalis new subspecies

Type—Adult female, number 102,011, Museum of Vertebrate Zoology, obtained at Oxalis, San Joaquin Valley, Fresno County, California, by Mary C. Ramage on April 20, 1945; original number 85.

Diagnosis—A dark, dull race of *Myotis yumanensis*. Color above ashy-brown to blackish; whitish beneath. The buffy and reddish colors of *sociabilis* and *saturatus* tend to be lacking in *oxalis*.

Range—The central San Joaquin Valley, the lower Sacramento Valley, and the area about San Francisco Bay.

Specimens examined—Total, 81. *Fresno Co.*: Oxalis, 37; *Merced Co.*: Dos Palos, 2; *Yolo Co.*: Davis, 3, 1 mi. E Davis, 2; *Alameda Co.*: Berkeley, 23, Calaveras Dam, 1000 ft., 12, Mt. Eden, 1; *Contra Costa Co.*: St. Mary's College, 1.

Remarks—The blackish to ashy-brown color of *oxalis* is distinctive. The specimens from within the range here assigned to *oxalis* cannot be placed with the rich, reddish-brown *saturatus* or with the yellowish-brown *sociabilis*. The race seems to be characterized by relatively small amount of reddish pigment. The reduced reddish pigment is not an intermediate stage between *saturatus* and *sociabilis*, although in some specimens of both of these races the reddish pigment is reduced. Varying degrees of intermediate condition between these two races are known from elsewhere in California, and the intermediates are reddish.

Specimens are not available to show the area of intergradation between *oxalis* and *sociabilis*. The series from Tejon Ranch, 1300 ft., Kern County, was obtained at the base of the foothills at the southern end of the San Joaquin Valley. These bats are like typical *sociabilis*. It is possible that this species of bat does not live on the floor of the valley between the hills and the river.

Specimens from the northern Sacramento Valley, notably from Butte County, are intermediate between *saturatus* and *oxalis*. Some specimens are like *oxalis* but most of them resemble *saturatus*.

Specimens from the San Francisco Bay region also show a tendency toward *saturatus* but are, on the whole, like *oxalis*. Probably the Sacramento River, draining the interior valley range of *oxalis*, has allowed *oxalis* to come westward in this area.

MYOTIS YUMANENSIS SATURATUS Miller

Type—From Hamilton, Skagit County, Washington.

Diagnosis—Color rich dark reddish above; buffy below.

Range in California—The northern Sierra Nevada, the coast ranges north of San Francisco Bay and a narrow belt along the ocean coast from San Francisco Bay southward to San Luis Obispo County.

Specimens examined—Total, 93. *Del Norte Co.*: E Fork Illinois River, 1/4 mi. S Oregon line, 5, Rowdy Creek, 1 1/2 mi. E Smith River, 1; *Humboldt Co.*: Carlotta, 2, Cuddeback, 1; *Tehama Co.*: 14 mi. E Red Bluff, 600 ft., 1; *Glenn Co.*: Winslow, 5 mi. W Fruto, 1; *Butte Co.*: 9 mi. S 6 mi. W Chico, 100 ft., 1, 1/2 mi. S Oroville, 14, Chambers Ravine, 600 ft., 4 mi. N Oroville, 1; *Placer Co.*: 1/2 mi. NE Dutch Flat, 1, Lake Alta, 3/8 mi. SW Alta, 3; *Eldorado Co.*: Fyffe, 1; *Calaveras Co.*: 2 mi. S San Andreas, 1; *Mariposa Co.*: Floor of Yosemite Valley, 1; *Mendocino Co.*: Lake Leonard, 10 mi. NW Ukiah, 1; *Lake Co.*: Long Valley, 14, Lucerne, Clear Lake, 7, Clear Lake Lodge, Clear Lake, 1, Lower Lake, 1; *Marin Co.*: Inverness, 100 ft., 1; *San Mateo Co.*: 3 mi. ENE Pescadero, 1; *Santa Clara Co.*: 2 1/4 mi. NW San Felipe, 1; *Santa Cruz Co.*: Forks of Waddell Creek, 100 ft., 8, Mouth of Baldwin Creek, 5 mi. W Santa Cruz, 1; *Monterey Co.*: Castro Canyon, about 4 mi. SE Big Sur Park, 1; Mouth of Limekiln Creek, near Lucia, 18, 1 1/4 mi. S Chalk Peak, 3000 ft., 1; *San Luis Obispo Co.*: San Simeon, 1, San Carpojo Creek, 7 mi. N Piedras Blancas Light House, 1.

Remarks—Californian specimens of *saturatus* differ little from specimens obtained in western Oregon and Washington. The northern materials perhaps average slightly richer in color. Some specimens from western Washington have a slight wash of bronze over the back, caused by light-tipped hairs. This is not present in material from California. There is considerable variation in both darkness and redness throughout the range of *saturatus*.

Miller and Allen (1928) considered the northern Sierra Nevada to lie within the range of *sociabilis*. They had but four skins from this area, however. More recently acquired material shows that *saturatus* occurs there.

Almost no geographic variation was found in size. No two collectors seem to measure bats in the same way. Measurements of foot and ear, especially, are taken in different ways. The measurements of Dr. Seth B. Benson, Miss Mary C. Ramage, and the writer are taken in much the same manner and, as a result, are fairly comparable. The following are by the writer alone, by Benson and Dalquest, by Ramage and Dalquest, or by all three together. Only adult females are included. Measurements are to the nearest millimeter.

Mean Measurements of Adult Female *Myotis yumanensis*

	Number	Length	Tail	Foot	Ear	Tragus
(*yumanensis*)						
Wadsworth, Washoe Co., Nevada	25	84	36	9	14	7
(*sociabilis*)						
Tejon Ranch, Kern Co., Calif.	7	84	35	9	14	7
Lebec, Kern Co., Calif.	16	83	35	9	14	7
NW Old Fort Tejon, Kern Co., Calif.	8	83	35	9	14	7
(*oxalis*)						
Oxalis, Fresno Co., Calif.	37	84	35	9	14	7
Calaveras Dam, Alameda Co., Calif.	8	83	35	9	14	8
Berkeley, Alameda Co., Calif.	22	84	36	9	14	7
(*saturatus*)						
Limekiln Creek, Monterery Co., Calif.	12	84	36	9	14	7

Geographic variation in *Myotis yumanensis* in California may be summarized as follows: a dark reddish race in northwestern California and in a narrow strip along the coast south of San Francisco Bay; a dull, blackish form in the Great Valley and west along the Sacramento River; a pallid race in suitable areas in the southeastern deserts; a pale, brownish form between the ranges of the desert race and the darker forms to the north and west.

The distribution of *saturatus* along the humid northwest coast is to be expected. Many races of mammals typical of the humid coast belt enter this section of California. The presence of *saturatus* in the Sierra as far south as the Yosemite area has been overlooked in the past but is not unexpected. *Myotis yumanensis saturatus* is a race of the coniferous forest, and such habitat is present in the Sierra.

The presence of *saturatus* in the coastal belt as far south as San Luis Obispo County was pointed out by Miller and Allen (1928) and is well shown in recently collected material. This area is unusual in several respects. The coast line is rough with cliffs and hills immediately back of the beaches. The hills are rocky. Along the beaches and sea cliffs, vegetation consists of dense brush and annuals. Farther back the hills are grassy with dense chaparral and groves of oak. Numerous small streams flow from the hills to the ocean through deep canyons. These canyons and the cold, clear streams support redwoods and fir. Thus isolated pockets of redwood forest exist along the coast and *Myotis yumanensis saturatus* is abundant there. The open areas betwen the redwood canyons scarcely seem suitable to *Myotis yumanensis*. At the mouth of Limekiln Creek, Monterey County, we hunted bats over a fresh-water pool on the ocean beach. The canyon behind was typical redwood forest but the hills on each side were clothed with chaparral and grass. Both *Myotis yumanensis saturatus* and *Pipistrellus hesperus* were collected. The first is a bat of the coniferous forest while the latter is usually associated with desert canyons and arid regions.

How far inland *saturatus* extends along the coastal strip is not known. If, as seems likely, *saturatus* is confined to a narrow area, south of San Francisco Bay, it shows extreme habitat restriction. This population of *saturatus* may have existed in its present range since the time the redwoods were of continuous distribution along that part of the coast, or the population may have developed the color of *saturatus* because local selective factors are similar to those of the coniferous forests farther north. In either case, the retention of the *saturatus* color shows that no great mingling with either *oxalis* or *sociabilis* has occurred and these forms occur near the coastal strip occupied by *saturatus*.

The presence of the dark, dull race, *oxalis*, in the San Joaquin Valley was unexpected. The relatively few specimens of this race obtained previously had been referred to either *saturatus* or *sociabilis*. The large series from the type locality called attention to the existence of a distinct race in central California. In as much as the San Joaquin Valley is relatively arid, one would expect the bats to be pale rather than dark.

The range of *sociabilis* in California is about what might be expected of a race intermediate between the pale desert and darker coastal forms.

Genetically the bats assigned to *sociabilis* in California are probably more closely related to bats of other subspecies in California than they are to bats of, for example, Idaho or Montana, referred to *sociabilis*.

Part of the range of *sociabilis* in California seems to result from actual intergradation of other races. In other parts of the range, the bats may have developed an intermediate color due to intermediate environmental conditions. The single specimen from the San Bernardino Mountains is like *sociabilis*. Conditions in the San Bernardino Mountains are relatively humid. To the north, east and south are arid deserts. The retention of *sociabilis* color in an area partially surrounded by desert indicates relative restriction of range.

Daytime Retreats

Myotis yumanensis has so completely adapted itself to man-made structures that we have no records of the species being found in a "natural" retreat. Daytime retreats seem to be of two types: favored and temporary. By favored is meant a retreat regularly occupied by a colony or an individual. A temporary retreat is a hiding place utilized only at intervals.

A. B. Howell (1920, p. 173) gives an account of 600 *Myotis yumanensis yumanensis* found in the Old Senator Mine on the Colorado River. The bats were in the 100 and 200 foot levels.

At Wadsworth, Washoe County, Nevada, a colony of about 5,000 *Myotis yumanensis yumanensis* were in the belfry and attic of a church on June 12, 1944. They entered through ventilation windows of the belfry, 35 feet from the ground. Droppings covered the floor to a depth of about three inches. The air was damp and warm. An odor somewhat resembling that of dried peanuts was almost overwhelming. The odor was doubtless from the guano. Bats covered the ridgepole, rafters and the upper two feet of vertical supports. They did not enter crevices that were available but remained in the open. The bats were active and the ceiling seemed to twinkle as they moved about, alternately showing pale underparts and darker backs. Three large handfuls were gathered and included over 100 bats, all females.

The presence of *Myotis yumanensis yumanensis* in a mine in Imperial County and in the cave-like church attic at Wadsworth, Nevada, suggests that this race is normally a cave type. Howell does not state that crevices were available to the bats in the Old Senator Mine, but they were available to the bats in the attic at Wadsworth and were not occupied.

The history of the colony of *Myotis yumanensis sociabilis* at Old Fort Tejon, Kern County, is interesting. Old Fort Tejon is in a canyon on the slopes of the Tehachapi Mountains. A few miles to the north is the flat, arid San Joaquin Valley. Four or five miles to the south, east and west are the piñon and juniper-covered crests of the Tehachapis. The Joshua trees and creosote bush of the Mojave Desert are 15 or 20 miles eastward. Grapevine Canyon, in which the ruins are located, has a cool stream, a lake, marshes and extensive groves of tall oaks.

T. S. Palmer visited the fort in July, 1891, while with the Death Valley

Expedition. His account of the bats is given by Miller (1897, pp. 84-85). "A long, two-story adobe building with the roof still intact, seemed to be the center of attraction, and about sundown bats could be seen streaming forth from a window in one of the gables. On the morning of July 5 an examination was made of the attic of this building, and the bats were found clinging to the ridgepole and the rafters, literally by the thousands. Individuals of all ages, from recently born young to adults, were hanging together in bunches as big as a bushel basket. Others found concealment in cracks and crevices, but very few were flying about." Both *Myotis yumanensis sociabilis* and *Myotis thysanodes* were present. Of 25 specimens saved, 9 were *yumanensis* and 16 were *thysanodes*.

Joseph Grinnell (1905) collected at Old Fort Tejon from July 21 to 25, 1904. His account of the area is very complete. Concerning the bats, he says, "I have never anywhere seen such great numbers of bats as made their appearance at early dusk. They made their way in veritable streams out of the attics of buildings, hollows of treees, and even crevices in the adobe walls." The 61 specimens saved are all *Myotis yumanensis*.

A. B. Howell visited the fort in 1919. A galvanized iron roof was placed on such buildings as remained standing in 1917. On September 3 about 1000 bats were in crevices along the peak. On September 23 only about 200 were present and on December 16 none was found. Howell found only *Myotis yumanensis* at the fort.

On June 2 and 4, 1945, Miss Mary C. Ramage and the writer visited the fort. *Myotis yumanensis* were not present, though *Myotis volans, Eptesicus fuscus* and *Tadarida mexicana* were found. Dr. Seth B. Benson and the writer stopped at the fort on June 20, 1945, but found no bats of any kind.

A small colony of *Myotis yumanensis* was located in the old power house (Fig. 2), 1 mi. NW Old Fort Tejon, Kern County, on June 3, 1945. The power house, like Old Fort Tejon, is in Grapevine Canyon. It measures about 30 by 50 feet, has concrete walls 20 feet high, and a sloping, galvanized, corrugated iron roof. Bats were in crevices between loosely-fitting overlapping sections of metal roofing. A series of 15 bats, frightened from their retreats and shot, included 14 *Myotis yumanensis* and a *Myotis volans*. Two *Myotis californicus* were found in tiny U-shaped crevices formed by the intersection of the corrugations of the metal roofing and supporting boards. A number of *Tadarida mexicana* lived between the iron roof and thick concrete walls. This locality was revisited by Seth B. Benson and the writer on June 20, 1945. The only bats found on this date were *Tadarida mexicana*.

At the Tejon Ranch, 1300 ft., Kern County, Benson and the writer found four *Myotis yumanensis sociabilis* in the attic of the ranch store on June 18, 1945. The bats were females and four small babies were clinging to them or to the walls near them. They were in a crevice betwen the ridgepole and a brick chimney. *Myotis thysanodes* and *Tadarida mexicana* were found in other parts of the attic. On June 19 and 20 no *yumanensis* were found in this attic; but the crevice, occupied by *yumanensis* on June 18, was inhabited by *Myotis thysanodes*. On June 19, two lactating female *Myotis yumanensis* were found in a barn near the ranch store. They were clinging to the roof

in a dark part of the barn and were tightly wedged into a crevice formed by two rafters that joined at a 30° angle. A *Myotis volans* was found in a similar crevice a few feet away.

The few favored retreats of *Myotis yumanensis oxalis* thus far found are much like those of *sociabilis*. On April 8, 1945, a male was found in a crevice on the porch of the Dos Palos High School, Dos Palos, Merced County. The crevice was about 8 feet above the porch floor. A *Tadarida mexicana* was in the same crevice a foot from the *Myotis*. Mr. Eric Van Atta told us that about 150 *Myotis* had been killed in this crevice a month earlier. The land about Dos Palos is flat and under cultivation: rice, barley, cotton and orchards. There is uncultivated land supporting cottonwood and willow thickets along the San Joaquin River a few miles away.

A colony of about 1500 *Myotis yumanensis* and 300 *Tadarida mexicana* was found in a warehouse at Oxalis, Fresno County. The warehouse is a one-story wooden structure about 100 by 35 feet and 30 feet high. Bats enter and leave the building through slotted ventilation windows near the peak of the end walls. When we first entered the building, several clumps of from five to 50 bats were clinging to the ridgepole and ceiling. The greater part of the colony was in a crevice between the paired boards that formed the ridge pole. All of the 42 specimens collected were females. We returned to the warehouse on May 3, 1945, and although the bats were much scarcer than on the earlier visit there were a few clumps near the ridgepole. A shot into one clump brought down five female *Myotis* and two *Tadarida mexicana*. The area about Oxalis is flat with extensive fields of cotton, flax, rice and other grain. There are marshes nearby and numerous irrigation canals.

Mr. Thane A. Riney showed the writer where he had found bats at the Hearst Mining Building at Berkeley in 1941. On the tile roof of the building, about 60 feet from the ground, are three air-intake ventilators in the form of hexagonal spires about 10 feet in diameter and eight feet high. One is located at the west end of the building, one at the east and one to the north. These ventilators are roofed with arched tiles. The tiles are placed in such a manner that they form a series of tiny caves along the edge of the roof. Overlapping makes the size and shape of the openings variable but most of them are semicircular and about five inches across. Many of the openings are plugged wtih plaster but others are open for several feet.

This locality was visited at intervals in the spring and early summer of 1943, 1944 and 1945. Unfortunately, few records were kept of visits that revealed no *Myotis*. These unsuccessful visits were probably twice as numerous as those upon which bats were taken. The following were recorded:

June 2, 1942.—1 male *Myotis yumanensis* captured, 1 *Tadarida* seen.
June 6, 1943.—2 *Tadarida* seen.
June 7, 1943.—1 *Tadarida* seen.
June 10, 1943.—1 female *yumanensis* and young male captured.
June 29, 1943.—6 *yumanensis* seen, 1 female captured.
June 30, 1943.—2 *yumanensis* seen.
July 1, 1943.—3 *yumanensis* seen.
July 2, 1943.—2 *Tadarida* seen.
July 8, 1943.—5 *yumanensis* seen, 2 females captured.

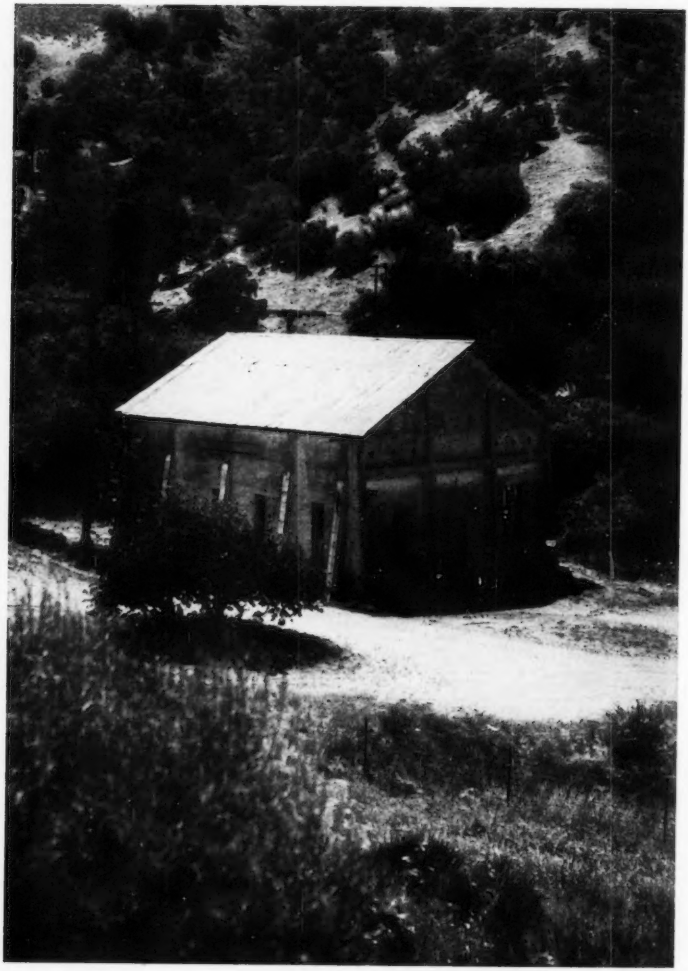

Fig. 2.—Habitat of *Myotis yumanensis sociabilis* near old Fort Tejon, Kern County, California. The concrete building in the foreground was inhabited by *Myotis yumanensis* and three other species of bats on June 3, 1945.

June 17, 1944.—1 female *yumanensis* captured.
July 9, 1944.—2 female *yumanensis* captured.
July 26, 1944.—1 female *yumanensis* captured.
February 20, 1945.—1 female *yumanensis*, 1 *Antrozous* captured, 2 *Tadarida* seen.
February 28, 1945.—1 bat (*Myotis* ?) seen, 2 *Tadarida* seen.
March 6, 1945.—1 female *yumanensis* captured, 2 *Tadarida* seen.
March 7, 1945.—1 female *yumanensis* captured, 3 *Tadarida seen.*
March 21, 1945.—1 female *yumanensis* captured.
March 26, 1945.—2 *yumanensis* seen, 1 female captured
March 27, 1945.—No bats seen.
April 3, 1945.—1 female *yumanensis* captured.
April 11, 1945.—1 female *yumanensis* captured.
April 25, 1945.—1 female *yumanensis* captured.
April 26, 1945.—No bats seen.
April 27, 1945.—No bats seen.
May 24, 1945.—1 female *yumanensis* captured.

Bats were taken in the roofs of all three ventilators. No choice of direction in which the opening faced was observed; openings facing north, south, east, or west were used indiscriminately. In all but a few cases the bats were in the corner holes. These were darker than most of the other openings. One side of each of two ventilators overhangs the roof with a 60-foot drop to the ground below. These sides had openings suitable to bats and were sometimes utilized by *Tadarida*. *Myotis*, however, were never found there. Bats were found only under the tile roof of the ventilators; never in similar openings in the tile roof of the main buildings. Droppings were seen about some of these openings, however, indicating that they were used at times.

The tile openings were commonly inhabited by black widow spiders. *Myotis yumanensis* seems to have no fear of this spider. Several times a black widow was noted in an opening. On the next visit, in one case the next day, the spider and its web were gone and a bat was in the hole. Though comparatively odorless itself, *Myotis yumanensis* seems not to mind the odor of other bats. They were commonly found in openings that smelled strongly of *Tadarida* and, less commonly, in openings that bore the strong, skunk-like odor of *Antrozous*. *Myotis yumanensis* was never found in a tile opening with a *Tadarida* at Berkeley, though the two species were found together elsewhere.

This tile roof is thought to be only a temporary retreat, occupied by bats irregularly. Perhaps individual bats occasionally find themselves too far from their more regular retreat to return before dawn and so have alternative retreats. Perhaps some other factor is responsible for the irregular occurrence of bats here.

On the roof of this same building there is an established colony of *Tadarida mexicana*. The bats live in a crevice behind drain pipes that ring two large window wells. On March 6, 1945, a *Myotis* was behind the drain pipe with the *Tadarida*. It escaped capture but was tentatively identified as *yumanensis*.

On April 26, 1945, a janitor in this building reported that bat droppings were accumulating beneath a doorway in the lower floor. The doorway was found to be the entrance of a hallway, often used by students. Eight bats were seen in a crevice measuring five feet in length, three-quarters of an

inch wide, five inches deep, and situated about 15 feet from the floor. The light in the hall was dim; the upper portion of the crevice was in complete darkness. Three *Myotis yumanensis* were collected. Each was a female in a late stage of pregnancy. No bats were found in this or similar crevices in the Hearst Mining Building in the next month. On July 17 the crevice was occupied by seven or eight bats. The accumulated droppings indicated that bats had been living there for several days, at least. Three of these, all *Myotis yumanensis,* were captured and found to be well-grown young of the year.

Both *Myotis yumanensis sociabilis* and *Myotis yumanensis oxalis* seem to be crevice-living forms. Their natural retreats probably include caves, hollow trees, loose pieces of bark and cracks in dead trees.

Myotis yumanensis saturatus seems to be a forest haunter. No colonies approaching the size of those reported for the other three races are known. We have found *saturatus* in its daylight retreat on several occasions, but most of the specimens collected were obtained by other means.

The retreat of a male was found 2¼ mi. NW San Felipe, 200 foot elevation, Santa Clara County, in a long-abandoned house near Soap Lake. A lump-nosed bat (*Corynorhinus*) was found in the attic. A *Tadarida mexicana* was in a crevice above a door and a *Myotis californicus* was behind a loose bit of wallpaper. The *Myotis yumanensis* was between the ceiling of a closet and a bit of cardboard. The cardboard had been tacked to the ceiling but had sagged, leaving a narrow, horizontal crevice. The bat was lying flat in this crevice. When disturbed it circled the room, and entered the attic through a trap door. There it lit on a rafter and was captured. It did not hesitate on entering the attic but flew directly through the trap door, as if familiar with the attic from past experience. The area about Soap Lake constitutes a number of rolling, grassy hills with scattered oaks. Along the lake are marshes and dense cottonwoods.

At San Simeon, San Luis Obispo County, we looked for bats in a seldom-used warehouse on June 24, 1945. Bats were in crevices between the shingle roof and end walls. In some crevices we found pallid bats (*Antrozous pallidus*) but the commonest species present was *Tadarida mexicana.* Two *Myotis* were in one crevice. One escaped. The other was a male *yumanensis.* A lump-nosed bat (*Corynorhinus rafinesquii*) was found in an attic connected with the warehouse.

Another male *Myotis yumanensis saturatus* was found in an inhabited, two-story house near the mouth of Castro Canyon, about five miles southeast of Big Sur Park, Monterey County, on June 27, 1945. The house was of natural redwood timber and was situated in a redwood forest. The bat was clinging to the shady side of the ridgepole in the dim, seldom-visited attic. A male *Myotis californicus* was in a similar situation 15 feet away.

On June 28, 1945, a male *yumanensis* was found in the attic of a barn at the mouth of Baldwin Creek, Santa Cruz County. The bat was in a crevice between the shingle roof and a rafter. The attic was dark and dusty. A *Myotis thysanodes* was in a similar niche 20 feet away.

A mixed colony of *Myotis* was found to occupy spaces under the warped boards of the "shake" roof of an old cabin at the forks of Waddell Creek, 100 feet elevation, Santa Cruz County. This area is redwood forest. On June 29, 1945, I climbed to the top of this roof and pounded on shakes and ridgepole. Many bats emerged and escaped but others flew into the cabin where they were knocked down and captured by Dr. Seth B. Benson. The bats captured included: 2 *Myotis yumanensis saturatus*, 6 *Myotis californicus* and 1 *Myotis evotis*. The bats seemed to come from several different retreats. Whether the species were hiding together or separately could not be determined.

Other bats were found in the shake roof of an old sawmill nearby. Only the roof of the mill is standing. Most of the bats discovered managed to escape. One crevice, in particular, seemed to be favored. A *Myotis yumanensis* and a *Myotis californicus* were collected here, and at least one *Myotis evotis* was among the 20 or so bats that emerged and escaped.

On June 30, 1945, we searched for bats in the attic of an abandoned house three miles east-north-east of Pescadero, San Mateo County. Two *Eptesicus fuscus* were found clinging to rafters. While we were engaged in capturing these, four *Myotis* emerged from an unnoticed retreat and flew about the room in circles. They included: 1 *Myotis yumanensis*, 1 *Myotis thysanodes*, 2 *Myotis californicus*.

All daytime retreats of *Myotis yumanensis* examined by the writer have certain things in common. All were within a short distance of water. All were near trees. All were places where the light was dim. In most cases the retreats consisted of or contained dark crevices in which the bats were found and which were not ordinarily visited by humans. Notable exceptions to this are the school building at Dos Palos and the hall of the building at Berkeley.

Flight and Hunting

The flight of bats is difficult to describe in other than comparative terms. The following notes are from captive specimens taken at Berkeley, California.

When placed on a flat surface, the bats spread their wings and, with a few quick beats, were in flight. In four short spirals, four feet in diameter, one specimen attained a height of seven feet, or 18 inches from the ceiling. Others made spirals of up to 12 feet in diameter in gaining a similar height. The wings move over a wide arc. Wing beats are steady; flight is not interrupted by gliding. The tail membrane, as seen from the side and slightly below, moves up and down slightly with each wing beat. Flight seems to consist entirely of curves. One individual made a complete circle in a space that could scarcely have been a foot in diameter.

The bat approaches a selected landing place from below. The wings are set and the bat swoops up at a 45° angle. The upward rise is usually about 12 inches. Thus gravity helps break the force of the landing shock. The wings are half-closed and the bat strikes lightly, head up. The legs are stretched widely and the interfemoral membrane is expanded. Crevices are

Fig. 3.—Hunting ground of *Myotis yumanensis yumanensis* along the Truckee River at Wadsworth, Nevada. A colony of about 5000 bats occupied the attic of a church about 100 yards from the scene of this photo on June 12, 1943.

gripped with claws of feet and thumbs. After a momentary pause the bat turns. The tail membrane is kept expanded as the bat quickly shifts to three or four different grips with both feet and thumbs in turning. Most turns are counter-clockwise.

When the turn has been accomplished the wings are drawn in. The tips are drawn up and rest on the small of the back. The feet are drawn together until they extend straight back from the knee joint. The tail is relaxed and the terminal part is curved in and down in almost a semicircle. The knees are bent outward. The wrists are brought in almost to the chin. Commonly the bat begins to clean itself, licking first one wing and then the other but interrupts this occasionally to turn its head under in order to lick its chest. At rest the thumbs are held out and slightly backwards. The thumbs seem to support little, if any, of the weight of the body. Flight is accomplished with an outward pitch and a swoop of about 18 inches.

At Wadsworth, Washoe County, Nevada, we watched a colony of *Myotis yumanensis* emerge from slotted ventilation windows of a church belfry and begin their evening hunt. Observations were made on the evenings of June 12 and July 17, 1944. Shortly after sundown the bats showed increased activity by loud squeaking. It was nearly dusk before they began to squeeze out between the window slots, first by twos and threes, then in larger groups, until a steady stream poured forth. Some emerged with a downward swoop of only a few inches. Others descended 10 or 15 feet before leveling off. They did not circle the church but flew swiftly to the Truckee River (Fig. 3), a hundred feet away, in a smooth curve. They flew swiftly and erratically over the jungle of willows and cottonwoods. They filled the air, 10 to 50 being in sight at a time. Rarely did they fly more than 30 feet from the ground. In most cases they skimmed the tops of the low trees. Not until they had fed for several minutes did individuals begin to drink. Two hours after dark we found no bats along the river, though they were seen and heard flying over the open desert a mile away and also about the street lights of the town.

On the evening of June 18, 1945, bats were observed flying over the reservoir of the Tejon Ranch, 1300 ft., Kern County. These were principally *Eptesicus* but included *Lasiurus cinereus* and *Myotis*. One *Myotis* was observed to fly along the water, about two inches from the surface. It had just completed a figure "S" in flight, the loops of which were six feet across, when it was shot and found to be *yumanensis*.

Dr. Benson and the writer hunted bats at the mouth of Limekiln Creek, Monterey County, on the evenings of June 24, 25, and 26, 1945. On the 24th, bats emerged early in the evening and flew along the swift, rocky stream through dense vegetation of redwood, buckeye and other trees. They flew erratically and at high speed. They flew over the open stream bed or through the branches of trees with equal facility. Five specimens were shot but three were swept away by the swift current. The two retrieved were *Myotis yumanensis*.

On the evening of June 25 we waited for bats at a pool formed by Limekiln Creek just above high-tide level on the ocean beach. The first one came

Fig. 4.—A bat trap at Lebec, Kern County, California. *Myotis yumanensis* and four other species of bats were captured when they came to rest in this small, dark building in the night of June 4, 1945.

gliding down from high above. It came with wings set at an angle of 80° from the vertical. Near the water it swooped, began to flutter over the surface, and drank. Other bats were seen darting over the surface of the stream above the pool. They remained where the water was swift or entered the dense willows along the shore. They remained a foot or so from the surface. Bats flew into the depths of the willow thickets, were lost sight of in the darkness, and were seen to emerge a minute or two later, at or near the point where they entered the thicket. The willows were scarcely over a yard in height. The bats entered and emerged from them at a point about a foot from the ground. After dusk the bats began to fly over the pond. The five bats shot were *Myotis yumanensis*. A canyon bat (*Pipistrellus hesperus*) was also obtained here.

On June 26 we returned to the pool on the beach. Bats behaved as previously, not coming out over the pool until dusk, but flying through the bushes and over the stream. After dusk they flew over the pool at a height of about one foot. Their general line of flight over the surface was straight for from 10 to 50 feet. This general straightness was varied with innumerable dips and swerves of from a few inches to six feet in one direction or another. Swerves to right or left seemed more common than dips or rises. Turns were usually made at right angles or slightly backwards. Turns at acute angles were less common. At the end of its general straight line of flight, a bat would slow down, rise somewhat, and make a smooth reversal of direction. Complete reversals were most common, though right angle turns also occurred. In contrast to the quick swerves in pursuit of insects, most changes of direction seemed to be premeditated. Occasionally a bat would swerve out of its line of flight and not return to the original course.

The flight described seemed to be a hunting flight. Individuals drank occasionally, but not until late dusk did extensive drinking occur. In drinking the bats made a short dip, skimmed the surface for a short distance in a straight line, and swerved up to the original flight level. If the observer was close, a tiny ripple could be noted on the water, caused, apparently, by the bat's lower jaw skimming the surface.

It has long been known that the leaf-nosed bat (*Macrotus*) and pallid bat (*Antrozous*) will retire at night to porches and buildings not inhabited by day. A similar habit has been reported for the long-legged bat, *Myotis volans* (Grinnell and Storer, 1924, p. 56). That this habit is common to many species and several genera of vespertilionid bats is a fact that, strangely enough, seems to have escaped notice. Resting places can often be closed when the bats are inside. Late-flying species, otherwise very difficult to collect, can easily be obtained in this manner.

Myotis yumanensis retires to resting places at intervals during the night. This species hunts at high speed and apparently fills its stomach in a few minutes. Individuals with stomachs crammed with insects have been taken at resting places 15 minutes after dusk.

Resting places of *Myotis yumanensis* often show little or no evidence of use. By careful search of the floor of abandoned, windowless cabins, house

attics, porches of buildings, and similar situations, droppings can usually be found. In some cases, however, no droppings were found on the floors of buildings in which bats were trapped and captured.

At Lebec, Kern County, Mary C. Ramage, Peggy Dalquest, and the writer used two small buildings behind the Lebec Hotel for bat traps on June 4, 1945. These traps took the following specimens: at 9:00 p. m., 1 *Antrozous pallidus;* at 11:00 p. m., 11 *Myotis yumanensis,* 3 *Myotis volans,* 1 *Myotis californicus,* 3 *Antrozous;* at midnight, 6 *Myotis yumanensis,* 2 *Myotis volans,* 1 *Corynorhinus rafinesquii;* at 3:00 a. m., 3 *Myotis thysanodes.*

At Weldon, Kern County, Dr. Benson and I found droppings of bats on the porches of the local school. One of four porches showed the greatest accumulation of droppings, and this porch was equipped with a drop net that enabled us to close the opening from some distance away. All four porches were visited at intervals. Three of the porches were used by *Antrozous,* and seven individuals were taken in the drop net. The other porch, seemingly as well suited to *Antrozous* as the other three, was visited only by *Myotis.* No *Myotis* were seen on the other porches. The droppings on the *Myotis* porch were all of small size. Droppings on the other porches were much larger. In this case there seemed to be a rigid division of territory between the two genera. In other cases, however, the two genera have been taken together in a resting place. Two of the *Myotis* were captured; both were *yumanensis.* Other individuals escaped, and it is possible that more than one species was present. *Myotis* were noted at the porch from 10:30 p. m. to 2:00 a. m., when observations ceased.

Two old cabins at the mouth of Limekiln Creek, Monterey County, were visited shortly after dusk on June 25, 1945. In the first, two bats were seen. One was captured and found to be *Myotis yumanensis.* The other cabin held a single *Myotis yumanensis.* A *Myotis thysanodes* was taken in this cabin the following night.

At the forks of Waddell Creek, Santa Cruz County, five old cabins served as bat traps on June 28, 1945. Taken in one night were: 3 *Myotis yumanensis,* 1 *Myotis evotis,* 1 *Myotis thysanodes,* 4 *Myotis californicus,* and 1 *Eptesicus fuscus.* The following night was unusually cold. Perhaps for this reason, or perhaps because we had disturbed many bats during the day, we caught only two bats in the cabins. One was *Myotis yumanensis;* the other *Myotis californicus.*

Breeding and Young

For much of the year the two sexes remain separated. The females gather in large or small colonies. The largest colony examined was at Wadsworth, Nevada, where it was estimated there were 5000 bats on June 12, 1944. Of 100 individuals taken at random, all were females. According to residents this colony is occupied throughout the year. A colony at Oxalis, Fresno County, was estimated to number 1500 individuals on April 20, 1945. All of the specimens taken were females. When visited again on May 2,

1945, the colony was much smaller, perhaps numbering 200. Our activities on April 20 may have caused the greater part of the colony to move. No estimates of the number of individuals present in other large colonies is possible. At the Tejon Ranch, 1300 feet elevation, Kern County, California, four females with young seemed to constitute a colony on June 18, 1945.

One mile northwest of Old Fort Tejon, Kern County, a colony of *Myotis yumanensis* lived beneath loose pieces of roofing metal. These bats were out of reach, but 15 were frightened from their retreats and shot on June 3, 1945. Five males were included in this series. The males may, however, have been separated from the females in the various crevices in the roof.

Males of *Myotis yumanensis* are commonly found alone. Occasionally they occur with male bats of other species. At 2¼ mi. NW San Felipe, 200 feet elevation, Santa Clara County, we found a male *Myotis yumanensis* in an old building with a male *Myotis californicus,* a male *Corynorhinus rafinesquii,* and a male *Tadarida mexicana.* These four bats occupied different retreats in the building. At Castro Canyon, about four miles southeast of Big Sur State Park, Monterey County, a male *Myotis yumanensis* was found clinging to a ridgepole 20 feet from a male *Myotis californicus.* At San Simeon, San Luis Obispo County, California, two *Myotis* were found in a small opening between the roof and endwall of a warehouse. One was a male *yumanensis.* Similar crevices a few inches away contained *Antrozous pallidus* and *Tadarida mexicana.* All specimens of *Tadarida* collected were males. Two of four adult *Antrozous* captured were males.

Three miles east-north-east of Pescadero, San Mateo County, six bats found in an attic included two male *Eptesicus fuscus,* a male *Myotis yumanensis,* a male *Myotis thysanodes* and two male *Myotis californicus.*

The separation of sexes in *Myotis yumanensis* makes difficult an estimate of the numerical ratio of the sexes. At the mouth of Limekiln Creek, Monterey County, California, 18 specimens of *Myotis yumanensis* were shot over a pool and along a stream. This series includes six males and 12 females. Most series obtained at one locality on one day show a preponderance of females. When scattered records of one or a few individuals, taken on different dates or at different localities, are separated as to sex, males outnumber females. Of 50 such records, 30 are of males. The widely scattered males are probably more likely to be discovered simply because of the larger number of retreats they occupy while the colonial females live in fewer retreats.

Ten female *Myotis yumanensis* taken at Berkeley betwen February 20 and April 16, 1945, had swollen uteri. The uterine horns were firm and rounded. The right horn was usually larger than the left. Microscopic examination of some specimens revealed sperm. *Myotis yumanensis,* like the eastern *Myotis lucifugus,* probably copulates in the fall and the sperm remain dormant until spring.

Myotis yumanensis has a single young. There is variation in the stage of development of embryos in females collected at one locality and on one

date. There is also variation in the date of birth. The following data, from field notes and specimen labels, is arranged by day and month but not by year:

April 20, 1945.—*Oxalis, Fresno Co.* Each of 4 females contained an embryo from 2 to 6 mm. (diameter of fetal bulge).

April 25, 1945.—*Berkeley, Alameda Co.* A female contained a 4 mm. embryo.

April 26, 1945.—*Berkeley, Alameda Co.* Each of 3 females had a 15 to 20 mm. embryo.

May 3, 1945.—*Oxalis, Fresno Co.* Each of 3 females had a 6 to 11 mm. embryo. Two females were not pregnant.

May 14, 1918.—*6 mi. N Potholes, Imperial Co.* A female had a 7 mm. embryo.

May 14, 1933.—*½ mi. S Oroville, Butte Co.* Each of 4 females had a 6 to 12 mm. embryo; one female had a "small" embryo.

June 3, 1945.—*1 mi. NW Old Fort Tejon, Kern Co.* Each of 5 females had a nearly full-term embryo, 18 to 23 mm.

June 4, 1939.—*Lucerne, Clear Lake, Lake Co.* Each of 3 females had an embryo; 1 female was not pregnant.

June 4, 1945.—*Lebec, Kern Co.* Each of 14 females had a 12 to 20 mm. embryo; 2 females were not pregnant.

June 12, 1944.—*Wadsworth, Washoe Co., Nevada.* Each of 23 females had an embryo. Two females were not pregnant.

June 19, 1945.—*Tejon Ranch, 1300 ft., Kern Co.* A female had a full-term (22 mm.) embryo.

Probably the young are born, in most cases, before the middle of June. The *Myotis yumanensis* living in desert areas seem to have their young no earlier than those residing in more temperate areas.

Myotis yumanensis apparently does not carry its young while hunting. No young were found with lactating females shot in flight in the evening. It is possible that the young of some of these might have been present but were overlooked. In some cases, however, lactating females were taken in bat traps and the young of these were not present. Several lactating females, not accompanied by young, were found in daytime retreats. These, in all cases, were isolated females that had probably hidden for the day in temporary retreats, away from the main colony. The young might have been left at the colony since they are extremely hardy and might easily be left 24 hours without food.

The following data are from the field notes and specimen labels. The statement "young not present" means that the young bat was almost certainly not present. "Young not found" indicates that no special search was made.

May 24, 1945.—*Berkeley, Alameda Co.* Lactating female taken; young not present.

June 9, 1943.—*Berkeley, Alameda Co.* Lactating female with well-grown young; young bat probably able to fly.

June 17, 1944.—*Berkeley, Alameda Co.* Lactating female taken; young not present.

June 18, 1945.—*Tejon Ranch, 1300 ft., Kern Co.* Each of 4 lactating females was accompanied by a very small baby bat.

June 19, 1945.—*Tejon Ranch, 1300 ft., Kern Co.* Two lactating females; young not found.

June 22, 1945.—*Weldon, Kern Co.* Two lactating females; young not present.

June 24 to 26, 1945.—*Mouth of Limekiln Creek, Monterey Co.* Of 12 females taken, 8 were lactating; 2 had recently been lactating; 2 gave no evidence of having had young. No young were found.

June 25, 1931.—*Lake Hodges, San Diego Co.* Four young bats, probably able to fly.

June 28 and 29, 1945.—*Fork of Waddell Creek, 100 ft., Santa Cruz Co.* Two females taken gave no evidence of having had young. A young bat was shot in flight.

July 10, 1944.—*Berkeley, Alameda Co.* Two females had recently been lactating.

July 12, 1931.—*Long Valley, Lake Co.* A young bat, probably able to fly.

July 17, 1945.—*Berkeley, Alameda Co.* Three young bats, well able to fly.

July 22, 1933.—*Long Valley, Lake Co.* A young bat, shot in flight.

July 23, 1904.—*Old Fort Tejon, Kern Co.* 28 young bats, all probably able to fly.

August 4, 1939.—*½ mi. NE Dutch Flat, Placer Co.* A young bat of adult proportions (weight 5.7 grams).

Parasites and Enemies

Myotis yumanensis is surprisingly free of ectoparasites, as compared with many species of bats. Fleas are common; one to four occur on most specimens. A bedbug was found on the wing of one individual. No ticks, mites, lice or flies were found.

We have no record of any vertebrate preying on *Myotis yumanensis* in California. The rate of reproduction in this species (one young each year with a sizeable proportion of non-bearing females) indicates relative freedom from predation. These bats, at times, are exposed to enemies, such as snakes, in their daytime retreats, also they would seem to be easy prey for large fish when drinking. The bats seen to fly into the dense willow thickets at a height of a foot from the ground would probably be easy prey for a quick-moving predator such as a wildcat, raccoon or weasel.

An interesting contrast in the reactions of *Myotis yumanensis* and *Antrozous pallidus* was noted at Weldon, Kern County. Both species came to rest on porches. When we attempted to approach and capture them all but a few of the *Antrozous* made a headlong dive through the open door at the first alarm. A few were fascinated by the flashlight beam and remained for a few moments but all fled before we could reach them. The *Myotis*, on the other hand, were confused by our presence and circled about helplessly. *Antrozous* is a large, rather slow-flying species that catches some of its food on the ground. Probably *Antrozous* is more susceptible to the attacks of predators than *Myotis*. This species customarily has two young.

Several mummified bodies of *Myotis yumanensis* were found in daytime retreats. Presumably these animals died from natural causes. There is a specimen in the Museum of Vertebrate Zoology that was struck by an automobile.

Comments on Migration and Hibernation

A number of writers have expressed the belief that *Myotis yumanensis* is migratory or that the males wander far afield in summer. Howell (1920) bases his conclusions on the absence of the species at Old Fort Tejon, Kern County, in December. The bats of this locality were disturbed on his visits of September 3 and 23. The bats very likely left the fort because of the disturbance, rather than migratory activity. All colonies from which specimens were collected in 1945 were found to be much reduced or deserted on subsequent visits. These are discussed in the section dealing with daytime retreats. Migration in May and June seems unlikely, but these are the months when the colonies moved.

Miller and Allen (1928, p. 65) state "The adult males apparently leave the colony when the young are born, and during summer they may wander up to a considerable altitude in the open woods of the dry mountain country." There seems to be no evidence that the adult males are ever part of a colony. The colony at Oxalis, Fresno County, contained no males, as far as is known, when the females were in a very early stage of pregnancy. A few males were taken with females 1 mi. NW Old Fort Tejon, Kern County, when the females were in a late stage of pregnancy. Conditions for observation were very poor there and it is not known whether the males were with the females, or even together, except in the sense that they were in the same building.

The alleged wandering habits of the males is based, apparently, on G. M. Allen's (1919) record of a male from 11,000 feet elevation on Mt. Whitney and H. W. Grinnell's (1918) record of a male from 8,500 feet elevation in the San Bernardino Mountains.

It has been our experience that the males of *Myotis yumanensis* are largely solitary. They are widely scattered, as compared with the females, but apparently resident wherever found. Doubtless they, and females also, move around to a certain extent, but that they ever become habitually vagrants seems unlikely. Certainly the uniformity in color of series from some areas of intergradation, and other features of geographic variation in the species in California, indicates a high degree of racial "purity" in each locality. The specimen captured, banded and released at Berkeley and retaken at the same locality nearly four years later, indicates a highly developed home-range instinct.

Myotis yumanensis probably hibernates in the parts of California where winter temperatures are low. Hibernation is probably not complete. They also enter into dormancy at other times. Two of three specimens taken at Berkeley on March 26, 1945, were dormant. They were able only to squirm about in "slow motion." Their activity was regained in a few minutes, however. The third individual was completely active. Dormancy seems to be voluntary, at least not due to weather or temperature. *Myotis* at Berkeley were completely active when *Tadarida,* found a few feet away, were all dormant. Some *Myotis* were found to be completely active when frost lay upon

the ground. Other specimens found when temperatures were low were less active than usual but were far from dormant. An individual left in a refrigerator at a temperature of 35 degrees for eight hours appeared to be somewhat chilled but was awake and able to squeak and scramble about. A *Corynorhinus* in the same sack became completely dormant.

Most of the specimens of *Myotis yumanensis* in the Museum of Vertebrate Zoology were taken in early summer. There are no specimens from the months of December and January. There are specimens taken as late as November 29 and as early as February 3. Whether this two-months gap results from lessened activity of the bats or lack of field work is not known. The writer favors the latter explanation.

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MUSEUM OF VERTEBRATE ZOOLOGY,
UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIFORNIA.

Nests of the Florida Flying Squirrel*

Joseph C. Moore

Only within the last twenty-five years has it been known to science that North American flying squirrels may infrequently build outside nests of leaves and twigs as is common practice with regard to fox and gray squirrels. Such discerning field naturalists of the last century as John Bachman (1846, p. 221) and Robert Kennicott (1857, p. 70) stated that flying squirrels do not build outside nests. Some years after the turn of the century, however, examples of such nests began to be reported from the northern states and Canada. Stupka (1935, p. 4) found an outside nest of the northern species *Glaucomys sabrinus* in Maine, and Cowan (1936, p. 60) and Rust (1946, p. 319) added records of outside nests of this species from British Columbia and northern Idaho. Of the southern species *Glaucomys volans,* Snyder (1921, p. 171) discovered an outside nest in Ontario, Landwer also (1935, p. 67) found one and Burt (1940, p. 48) recorded two in Michigan. The writer observed one in Harmony hollow about four miles from Front Royal, Virginia, on August 25, 1933, against the trunk near the top of a twenty-five-foot red oak. Roughly spherical in shape, this nest was composed externally of leafy twigs from the nest tree, and upon climbing to it the writer frightened from it three young which were about forty-five days old. The tree stood in an open pasture just barely within gliding distance of a mature mixed hardwood forest. During the most extensive study of the breeding habits of a North American flying squirrel, Sollberger (1943, p. 169) in New York and Pennsylvania found more than thirty-five females with young in tree hollows but only one in an outside nest. He entertained serious doubts that flying squirrels actually build outside nests.

Since so little is known about the construction of outside nests by flying squirrels, that the best authority casts doubt on the existence of them, the discovery of a number of such nests in Florida is of some interest. A description of these outside nests, dens, and refuges of the Florida flying squirrel, *Glaucomys volans querceti* (Bangs), constitutes the scope of this paper.

Since collection of data on nests of the flying squirrel was subordinate to other field work, it proceeded without plan, and consisted almost entirely of nest hunting in an extensive turkey oak forest. Laessle (1942, p. 30) describes this forest association in detail and calls it *Pinus australis-Quercus laevis Association.* It is worthy of note that virtually all of my data relate to this forest association which Harper (1914) indicated to be a common and often predominating forest type in much of north Florida. However,

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in the mesophytic hammock where Blair (1935, p. 275) reported the flying squirrel, and in the xeric hammock, swamp, and bayhead where it also occurs, the nesting habits of this mammal remain unknown. All data were gathered on or near the University of Florida Conservation Reserve at Welaka, Putnam County, Florida, in the fall of 1940, spring of 1942, and spring, summer, and fall of 1946.

It has long been known that flying squirrels den in hollow trees. If the hollow tree is not too large, thumping the tree trunk with a heavy club or giving it a resounding kick with the heel of one's heavy boot will frequently bring out any flying squirrel occupants. Some flying squirrels found occupying woodpecker-holes, had for nesting only a small amount of chips left by the woodpeckers. Others had introduced a soft cup-shaped lining of the resilient fibers of cured Spanish moss. Pairs of adults, groups of siblings, females with nestlings, and females with nearly grown young have been found occupying woodpecker-hole dens. Made mostly by red-headed and red-bellied woodpeckers, many of these dens were not large enough for more than three or four individuals. An adult female with four nestlings is the largest number that I have seen in one such den. Woodpecker-hole dens which were occupied by flying squirrels at the time inspected were in no case found to contain scats.

Where flying squirrels denned in hollows larger than woodpecker holes, Spanish-moss nests were made in them. In the cases of certain very deep hollows, considerable quantities of Spanish-moss fibers were found filling the lower portions. These appeared in some cases to be remains of the nests of successive periods of occupation and were usually laden with scats and acorn shell fragments. In one case the bones of two flying squirrels were dug from the quart of dry scats which had shifted to the bottom of a large cavity.

For an animal so well adapted to arboreal activity one might expect to look for its outside nests in the tops of lofty trees, but it is a curious fact that these have been consistently observed in small trees or saplings at heights of from five to twenty feet, even in forests where the average tree height is thirty to forty feet. The outside nests from which I have taken or driven flying squirrels vary in complexity from a neat symmetrical structure of three layers of material to a casual space formed in a streamer of fresh Spanish moss.

The most complex nests observed were four found occupied by female flying squirrels and their very young broods in late summer. These nests were located against the trunks of small trees or saplings at heights of six, seven, twelve and fifteen feet. Globular in shape, each possessed a lateral opening adjacent to the trunk, an outside rain cover on the upper portion of leafy twigs from the nest tree, and a soft lining of Spanish-moss or palmetto fiber. Three were in turkey oaks (*Quercus laevis*) and one in a sand scrub oak (*Quercus virginiana geminata*). The best example of such a brood nest was walled in by a half-inch of fresh Spanish moss shaped like a hollow ball, thatched on the top half with turkey oak leaves and leafy twigs—no twig of which was longer than one inch—and entirely lined with a one-and-one-half-inch layer of resilient black fibers of cured Spanish moss, leaving a spherical

chamber two inches in diameter. Three other outside nests of the broodnest pattern were found. These were either empty or occupied by a single adult of unidentified sex. An exceptional one of these was built against the trunk of a sapling longleaf pine about fifteen feet up, externally constructed entirely of reddish, dry longleaf pine needles, and lined with a thick mattress of Spanish moss-fibers. It was neatly oval, with the long axis horizontal to the ground. This is the only outside nest observed to be constructed of pine straw.

Other neatly spherical, well-lined nests occur without a thatch of leaves and with the outside consisting wholly of fresh Spanish moss. These are usually lined with cured Spanish moss or with the shredded, red, fibrous material obtained from the bases of palmetto fronds. Although the usual location of flying squirrel outside nests is against the trunk or main upright of the nest tree, one example was discovered among the twigs of a live oak branch nine feet above the ground and twenty feet from the tree trunk. My field notes contain descriptions of five of the present type, although possibly more were examined.

Another type of outside nest was found to be composed entirely of leaves and leafy twigs from the nest tree and without a vestige of lining. A pregnant female was frightened from a nest of this type, and a similar nest was found only forty feet away from the first. The former may have been a brood nest under construction since the chamber was large and the leaves fresh. Three such unlined leaf nests have since been found. A feature peculiar to this type is that the naked bark of the tree crotch in which the nest reposes, may form the floor of the nest. Many layers of leaves arch over the chamber and entrance, forming the sides and roof of the structure. From one of these nests I counted sixty-nine separate leaves and four small leafy twigs. Probably twenty leaves were lost in getting the nest down to the ground. All five nests of this type occurred in turkey oak trees between six and twenty feet from the ground. On a farm near Brooksville, Hernando County, Florida, in September 1942 Craig Phillips of St. Petersburg, Florida, found a nest composed of grass. He wrote to me as follows: "The terrain was . . . scattered scrub oak and occasional other trees. One small oak near the rim [of a long-abandoned phosphate pit] contained a spherical nest . . . about six feet from the ground . . . visible from 100 yards . . . The nest was soft and quickly came apart, appearing to have been constructed entirely of dried grass . . . I think it notable that the nesting tree contained no hollows of any sort, and appeared more or less isolated from the surrounding scrub." He captured a pregnant female flying squirrel in the nest.

Large areas of second growth turkey oak (*Pinus australis-Quercus laevis Association*) contain very little or no Spanish moss, but in the areas where it does occur, nests of the flying squirrel may be found in streamers of this plant. The method of locating these nests consists in observing the streamer against the sun. Any nest present will show up as a dark patch. Manually examining streamers which occur within reach is to be avoided because of wasps which often nest inside them. These flying squirrel nests usually con-

sist of a Spanish-moss fiber lining built into a fresh wad of the moss. It may be thickened about the lining so as to form something of an additional layer. A few nests of this type have been observed in xeric hammock and bayhead as well as in the turkey oak association. Three subadults were ousted from a large nest of this type in a xeric hammock.

A variation of the above consists of a nest in a Spanish moss streamer, devoid of a lining and with only a little apparent rearranging of the fresh moss to form a walled chamber. Lone rutting males were routed from two such nests and an adult of undetermined sex emerged from a third. These nests were six, seven and nine feet high; two in turkey oak saplings and one in a dead scrub oak in scrubby flatwoods adjacent to the turkey oak area. In the case of the one in scrubby flatwoods no tree higher than fifteen feet could have been attained from the nest tree in less than two glides. One of those in the turkey oaks was similarly isolated from large trees in the middle of a forest opening.

Flying squirrels sometimes build on top of fox squirrel outside nest structures. In three cases fairly typical flying squirrel brood nests were constructed on a bare foundation of twigs left in a tree fork by apparent caprice of some fox squirrel. These were occupied by females with broods of young. In another case a rutting male flying squirrel was found to be occupying a neat new nest fashioned of fresh Spanish moss in the open hollow of a fox squirrel outside nest.

Much more frequently the Florida flying squirrel utilizes an old fox squirrel nest by burrowing into the bottom of the structure and hollowing out a chamber without adding material to it. Apparently females with young which outgrow the brood nest and gradually tear it apart, frequently resort to this type of housing. In examining over two hundred fox squirrel nests, I have ousted flying squirrels from ten and found sixteen others containing unoccupied flying squirrel chambers in the lower portions.

To a considerable extent flying squirrels also utilize nearby unoccupied fox squirrel nests as feeding stations when foraging at night. High in a loblolly bay tree in a bayhead I found one such feeding station which possessed the shell of a large turkey oak acorn even though the nearest turkey oak tree was one hundred feet away. At least three old flying-squirrel brood nests and a number of Spanish-moss streamer nests were discovered to be in use as feeding stations and latrines. It is not uncommon to find a freshly cut acorn shell in the chamber of a brood or other occupied outside nest but apparently these are not allowed to accumulate.

The use of old unoccupied outside nests as latrines probably occurs in conjunction with their use as feeding stations. In the case of one old brood nest the whole thickness of the under side was saturated with scats. However, two latrines were found which had never been nests and which contained no evidence of use as feeding stations. They were similar in construction, but one had been used much more than the other. Each was under a wad of Spanish moss situated about six feet high on the trunk of a small turkey

oak and was supported by the dead stub of a small branch. Holes about an inch in diameter gave entrance to the wad on either side close to the bark of the tree. The Spanish moss was hollowed out above the twig providing enough space for the flying squirrel to cling vertically to the bark of the tree, or sit on the little stub sheltered by the Spanish moss. In the case of the older latrine, a considerable accumulation of scats had infiltrated the moss for some distance below the perch, and five or six inches of the surface of the bark had been intensively gnawed. In no case were occupied outside nests found to contain scats.

Hamilton (1940, p. 469) indicates that flying squirrels forage on the forest floor, and Sollberger (1940, p. 289) observed them "root about the ground while feeding." Any other terrestrial habit has apparently escaped observation, although suspected perhaps by Seton (1929, p. 377) who remarks that no one has yet reported the flying squirrel taking refuge underground. It is of special interest, then that on April 7, 1942, members of two separate flying squirrel families, when routed from their nests, fled to underground refuges. One of these animals was immature and the other was an adult lactating female. Both holes were in sandy soil near low pine stumps and twenty-five or thirty feet from the nest trees. In each case the animal glided to within a few inches of the hole and immediately entered it. Upon examination, one of the holes was found to descend steeply six or eight inches to join a horizontal tunnel which was about the size of a *Geomys* burrow. No pocket gopher mounds were noted, but it seems very likely that the tunnel was of such origin.

An intimation of more involved subterranian activity was observed on April 26, 1942, when a nest was discovered fully twelve inches below the ground surface under a stump. The stump was one of several which when kicked over revealed a battery of radiating tunnels beneath. Most if not all of these tunnels were formed by decay of the lateral roots. The nest was constructed of Spanish-moss fiber, about the size of a flying-squirrel arboreal brood nest, and in it was some gray fur very much like that of *Glaucomys*. My two captive flying squirrels were molting at this time, but no fur occurred in any of the arboreal flying squirrel nests examined.

The following table summarizes numerically the nest data discussed in this paper:

	number found	*occupied*
Occupied woodpecker-hole dens	11	11
Other tree-hollow dens	6	0
Brood nests containing young	4	4
Other brood nests	3	2
Unthatched brood type nests	5	0
Unlined leaf nests	5	1
Lined streamer nests	6	1
Unlined streamer nests	3	3
Nests on fox squirrel nest base	4	4
Fox squirrel nests usurped	26	10
Totals	73	36

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UNIVERSITY OF FLORIDA CONSERVATION RESERVE,
WELAKA, FLORIDA.

BOOK REVIEWS

THIS GREAT AND WIDE SEA. By R. E. Coker. University of North Carolina Press, Chapel Hill, North Carolina, 1947. 325 pages, 23 figures, 91 plates.

Considering that more than two-thirds of the surface of the earth is covered with water which influences the activities and well-being of man in so many ways, it is an anomalous situation that so little attention has been given to the science of the sea. Those who are interested in learning more about the ocean, its movements, its inhabitants, its constituents, and its relation to man owe a debt of gratitude to Dr. R. E. Coker for bringing forth this well-planned, concise, fascinating volume. It does much to satisfy a long-felt need for a relatively brief, comprehensive presentation of some of the basic phenomena of life for marine plants and animals.

In the interests of brevity and to minimize technicalities, the author has oversimplified certain features of physical, chemical and biological oceanography, resulting in a few errors, and some omissions. As a whole, however, it is a book which will be useful to advanced students of oceanography as well as to the layman who desires to learn more about the world below sea level. The factual and philosophical treatment of oceanography in all of its varied aspects is interesting, informative, entertaining, and thought provoking.

Part I entitled "History and Geography" discusses the discovery of the seas, beginnings of oceanography, the pioneers in the field, the study of oceanography in America, and the size, depth, boundaries, and topography of the oceans. Part II is divided into seven chapters dealing in a semi-technical way with the chemical composition of sea water, its physical properties, the characteristics of bottom deposits, the broad features of oceanic circulation, water movements caused primarily by the winds, the biological relations of waves, tides, and upwelling, and the effect of solar radiations on oceanic phenomena.

The first two parts of the book are more than adequate to prepare the reader for Part III on "Life in the Sea" in which Dr. Coker is really at his best. Each of the seven chapters emphasizes the diversity, abundance, widespread distribution, struggle for existence, and the interrelationships of the plants and animals inhabiting the sea. The complex interrelationships of organisms with the marine environment and the factors which influence the distribution of marine animals are also stressed. While reading the chapters on ocean pasturage, marine plankton, bottom-dwelling animals, fishes, marine mammals, and birds, one senses that the author has been very close to the sea.

Methods of observing conditions in the sea are treated briefly throughout the volume. A selected bibliography of 46 titles supplemented by special footnote references provides a clue to further reading on the subject. Twenty-three charts or line drawings and 91 well selected photographs illustrate the text. A carefully prepared index increases the value of the book for reference purposes.

This Great and Wide Sea should do much to bring the ocean to land-locked readers and to increase the appreciation of all for the wonders of the other two-thirds of the earth. Dr. Coker makes his point that whether or not we are ready as social beings to see the lands of our globe as "One World," we cannot escape the fact that land, sea, and atmosphere are *one world*, the last great unexplored frontier.—CLAUDE E. ZOBELL, Scripps Institution of Oceanography, La Jolla, California.

NORTHERN FISHES WITH SPECIAL REFERENCE TO THE UPPER MISSISSIPPI VALLEY. By Samuel Eddy and Thaddeus Surber. 1947. Univ. of Minnesota Press, Minneapolis, XII+ 276 pp., 62 figures, 7 diagrams. $4.00.

The new edition of *Northern Fishes* is especially to be welcomed in the Middle West as the best semi-popular account of our numerous game fishes, about which a

great deal of misinformation is current, and about which innumerable questions come to museums, libraries, university departments of zoology, and to the sporting magazines. That most of these questions are answered in the pages of this book is immediately evident, and this immediately establishes its value to the libraries of such institutions and to public libraries in general.

A much greater usefulness for *Northern Fishes* will result if the book can be placed in the hands of all families in which there are fishermen of assorted ages. A better book to take on a fishing trip in Minnesota, Wisconsin, or Upper Michigan is difficult to envisage. The competent systematic account of the fishes of these states (and of course of adjacent Canada), makes possible ready identification of all of the game and food fishes and of most of the minnows and "rough fishes." The introductory chapters on "fisherman's luck," fishing technique, lake dynamics (the interrelations of fertility and oxygenation to fish production), fish populations, management of waters for fish production, improvement of lakes and streams, laws and propagation, and fish parasites form an excellent introduction to the natural history of fishes and to the broader field of limnology. The urgent matter of reconsideration of hatchery and stocking programs is clearly set forth. Four of the "figures" are color plates. Misprints and errors of the first edition have been corrected, and the nomenclature is in accordance with the most modern usage. There is an adequate index.—KARL P. SCHMIDT, Chicago Natural History Museum.

HERMON CAREY BUMPUS YANKEE NATURALIST. By Hermon C. Bumpus, Jr. University of Minnesota Press, Minneapolis. 1947. 141 pp., $2.50.

This interesting biographical study by the son of Professor Bumpus reveals that Hermon Carey Bumpus (1862-1943) was far more than a naturalist. However, his training and deep seated interests in biology and nature provided distinctive points of view which were carried into all of his diversified activities. The son has ably characterized his successes in varied fields in these words (page 53): "Throughout his long life, both in small matters and in great, it was characteristic of Professor Bumpus that he acted as a catalyzer. When the resulting development of organization was progressing smoothly, he gradually retired from the scene, though never before he had made his complete contribution." Even a very brief review of this biography cannot omit some mention of the diversity of his activities.

As a student at Brown University he came under the influence of two eminent teachers, John Whipple Potter Jenks and Alpheus Spring Packard, men of widely differing points of view. In his senior year he wrote the chapter on "*Reptiles of the World*" for the *Standard Natural History* of which his contemporary J. Sterling Kingsley was editor.

He spent the summer of 1884 at Annisquam, where Alpheus Hyatt had established one of the earliest marine laboratories. After one year of graduate work at Brown, he became Professor of Biology in Olivet College in Michigan. He left this position in 1889 to enter Clark where he was the first recipient of a Ph. D. degree under the distinguished faculty brought together for that newly established university. His thesis, on the development of the American lobster, was published the following year (1890) in the *Journal of Morphology*.

Before receiving his doctorate, Mr. Bumpus became assistant director (1889) of the Woods Hole Marine Biological Laboratory, to aid Professor Whitman. He continued to serve in this capacity until 1895 when he accepted the directorship of the older Bureau of Fisheries Laboratory at Woods Hole.

The period from 1890 until 1900 he devoted as Professor of Biology, developing graduate study at Brown. A. D. Mead and H. E. Walter were among the men trained by him. Even during this time, his boundless energies were spread in so many different directions that he completed but few programs of research. He held an especial interest in the applications of statistics to biological data and is particularly well remembered for his publication on "The Elimination of the Unfit, as

Illustrated by the Introduced Sparrow, *Passer domesticus*" which was published in the annual volume of "Biological Lectures" at Woods Hole in 1898.

In 1900 his activities became directed into entirely new channels. From 1900 until 1911 he served the American Museum of Natural History and became recognized as the foremost figure in museum education in America. He was largely responsible for many of the changes in policy which turned that and other museums from mere repositories of stuffed and preserved specimens to displays of life-like, natural ecological groups. One of the direct fruits of this leadership was his election as first president of the American Association of Museums (1906), an organization to whose founding and development he devoted much attention.

Changing interests and personnel in the American Museum made it evident that his function there had been fulfilled. In 1911 he entered upon an entirely new phase of his life work when he became Business Manager of the University of Wisconsin. A pioneer in this profession, he served with distinction until 1914.

As teacher, organizer, administrator and financial expert he added to this diversified background of experience those personal qualities which led to his being chosen as President of Tufts College (1915-1919) where he directed all of his efforts toward the liberalization of the curriculum and the strengthening of the college in every respect.

Following his retirement from official professional connections, he became engrossed in affairs of the National Park Service as Chairman of its Educational Advisory Board. It was while Dr. Bumpus was thus engaged that he was largely responsible for developing the idea of trailside museums where visitors to the parks and monuments may become familiar with nature's out-of-doors rather than with preserved specimens brought into a building.

This biography gives the picture of a man who was not limited to one or a few interests but rather of one who accepted the challenge to pioneer in many fields, on each of which he left a strong personal imprint.— HARLEY J. VAN CLEAVE, University of Illinois, Urbana.

SCIENTIFIC INSTRUMENTS. Edited by Herbert J. Cooper. Chemical Publishing Co., Inc. Brooklyn, N. Y. 1946. 305 pp.+ 269 text figs. $6.00.

This book comprises relatively non-technical descriptions of many types of scientific instruments in use today in the various branches of science. It is an easily readable book written primarily for the purpose of informing the scientist regarding instruments other than those with whose use he is well-versed, and has no intention of contributing to the information of the specialist in the use of any of them.

Instruments are treated under five sections within the book. The first section deals with optical instruments. In separate chapters of this section, Lenses, Cameras, etc., Microscopes including the electron microscope, Polarimeters, Photometers, Rangefinders, Refractometers and Interferometers, Spectroscopes, and Telescopes are discussed.

The second section deals with instruments of mensuration. This section is divided into nine chapters: Density, Dimension, Electrical, Fluid, Pressure, Temperature, Time, Speed, and Weight.

Section three includes navigational and surveying instruments. Topics discussed in this section are the Barometer, Barograph and Altimeter, Gyroscopic Instruments, Mariner's Compass, Sextant, Sounding Equipment, and Surveying Instruments. Section four is brief, and deals with testing of liquids with respect to their viscosity.

The fifth and final section is entitled Miscellaneous. Its chapters deal with acoustical instruments, calculating machines, hardness indicators, and vacuum tubes and thermionic valves.

The descriptions of the various instruments and the general principles of their operation are lucidly put forth. In a period in history such as the present, when instruments of all sorts are constantly in use in the advancing fronts of all the natural sciences, this book becomes an especially interesting contribution for those numerous scientists who are seeking simple and brief introductions to many instruments with which they are currently familiar by name only.— F. A. BROWN, JR., Northwestern University, Evanston, Illinois.